GEOLOGY OF VIGO COUNTY, INDIANA.

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INTRODUCTORY.

Vigo County is situated on the western boundary of Indiana, about midway between Lake Michigan and the Ohio River. It has an extent of 24 miles from north to south, and is a little less than 17 miles in average width, having an area of about 406 square miles.

The county is bounded on the north by Vermillion and Parke counties, on the east by Clay County, on the south by Sullivan County and on the west by Clark and Edgar counties, Illinois.

According to the United States survey, the county is in townships 10, 11, 12 and 13 north of the base line of Indiana, which is 38° 30′ north latitude; and in ranges 7, 8, 9, 10 and 11 west of the second principal meridian, which is 86° 28′ west of Greenwich.*

The Wabash River flows southwesterly through the county, so that about one-fifth lies west and four-fifths east of the river. The county is divided into twelve civil townships. On the north there are Nevins and Otter Creek east of the river and Fayette on the west; then Sugar Creek on the west, with Harrison and Lost Creek east of the river; then Riley, Honey Creek and Prairieton, and on the south Prairie Creek, Linton and Pierson, all east of the river.

The immediate valley of the river in Vigo County is from four to five miles wide, occupying about one-fourth the area of the county. The river at the ordinary stage of water has an average width of about 600 feet. Low water at Terre Haute, near the middle of township 12 north, is about 445 feet above sea level. The river and its flood-plain occupy the western third of the valley, the eastern portion being a broad terrace. The flood-plain or first bottoms rise from 14 to 20 feet above low water in the river, while limited areas of "second bottoms" rise from 10 to 15 feet above the flood-plain. The terrace rises from 50 to 75 feet above low water in the river, but toward the south, in Prairie Creek Township, it merges into the flood plain.

The highlands on either side of the valley have an elevation of from 100 to 200 feet above the river, the bluffs in some cases being quite

*Unfortunately the numbers of the ranges and townships were omitted on the map of Vigo County, accompanying this report. Pierson Township is 10 N.; Riley, 11 N.; Lost Creek, 12 N., and Nevins, 13 N. Two tiers of sections on the east side of Nevins Township are in range 7 W.; Pierson Township is in R. 8 W.; Linton in R. 9 W., and Prairie Creek in ranges 10 and 11 W.

abrupt. The greater part of the county is drained by the Wabash and its tributaries. The principal streams from the west are Brouilett's Creek, Coal Creek, Sugar Creek (with several large branches), Clear Creek and Hawk Creek. These streams rise in Illinois and flow southeasterly into the river through valleys from one-quarter to one-half a mile wide and from 30 to 80 feet in depth. The streams from the east are Otter Creek, Lost Creek, Honey Creek, Prairie Creek, Turman's Creek and Busseron Creek. Portions of Pierson and Riley townships are drained by Splunge Creek into Eel River. The valleys of the river and its tributaries seem to be the channels of an earlier drainage system that have been partly filled with sand and gravel, so that in many cases the beds of the present streams are from 25 to 100 feet above the rocky beds of the older channels. These smaller streams for much of the summer are "lost creeks," a fairly good stream among the hills disappearing in the sands and gravels of the main valley.

The rocks of the county, as seen in the bluffs and in the beds of streams, and as revealed in ordinary wells and mines, are the sandstones, shales, limestones and coals of the Carboniferous Age.

The soils are in general of glacial origin. In the valleys there are alluvial sands and clays and wide areas of black prairie soil resting on a subsoil of sand and gravel. On the uplands the top soil is usually a fine white clay, resting on a subsoil of yellow clay, which passes gradually into the boulder clay or hard pan which lies upon the bed-rock. Along the eastern margin of the main valley there are extensive areas of dune sand, and at some localities in the eastern bluffs there are thick beds of loess.

That portion of the county drained by Splunge Creek, slopes gently toward Eel River and the soil seems to be sedimentary, appearing to have been deposited over the bed of an ancient lake.

The temperature is that of the middle temperate zone, possibly somewhat modified by the waters of the river. The rainfall is generally abundant and well distributed. The soils are varied and fertile, producing a luxuriant growth of vegetation. A large portion of the terrace in the main valley and the greater part of Splunge Creek valley were originally prairies covered with valuable forage grasses, but the flood plains and uplands were covered with forests of oak, black walnut, yellow poplar, birch, maple, elm, ash, sycamore, hickory and other valuable trees.

In Vigo County the conditions are specially favorable for successful coal mining, for the growing of grain and market garden products, for stock raising and for many forms of manufacturing.

The population and wealth of Vigo County, being the second in the State, the growth and development of Terre Haute, the fourth city in the State, give some indication of the material resources of this county.

ELEVATIONS.

The elevation of the following important localities are taken from railway levels, and are adjustable to the level of the rail at the Union Station at Terre Haute, near the center of section 22–12–9. This point, as given by Gannett, is 492 feet above tide; by some it is given as 485 feet:

Rail at the Union Station (Gannett)	492 feet.
Ellsworth, on the Logansport road	492 feet.
Atherton, on the north county line	523 feet.
Hill one-half mile east of Atherton	625 feet.
Rosedale, one mile north of county line	537 feet.
Grant, on Big Four railroad	516 feet.
Fontanet, Nevins Township	539 feet.
Coal Bluff, on Otter Creek	553 feet.
Lodi, on the county line	564 feet.
Perth, on the plateau in Clay County	633 feet.
Point one mile west of Seelyville	596 feet.
Seelyville Station	585 feet.
A point one mile east of Seelyville	604 feet.
East county line on the Vandalia	583 feet.
Spring Hill Junction, west of center of section 11–11–9	516 feet.
Honey Creek bridge, northeast northwest 17–11–8	505 feet.
Lockport Station	569 feet.
Highlands east of Lockport	622 feet.
County line, on the Southeastern railroad	614 feet.
Honey Creek bridge, on the Evansville road	509 feet.
Youngstown Station	578 feet.
Albin's hill, beyond Youngstown	604 feet.
Hartford or Pimento	600 feet.
County line on Evansville road	575 feet.
Farmersburg, one-half mile south of line	573 feet.
The west county line on the Vandalia	544 feet.
Point one mile west, on the plateau	581 feet.
Station at St. Mary's	555 feet.
Sandford, on the county line west	625 feet.
Morainic Hills, near Sandford	655 feet.
Yaw's Hill, northeast quarter section 18–10–8	673 feet.
Crapo's Hill, northwest quarter section 20–10–8	663 feet.
Surface of Lake Erie	573 feet.
Surface of Lake Michigan	582 feet.

GENERAL GEOLOGY.

Vigo County is a portion of the eastern slope of the great central valley of North America, and has been involved in many of the major geological events of the continent.

The earth for the most part is composed of oxygen, silicon, aluminum, iron, calcium, sodium, potassium, carbon, magnesium, hydrogen, sulphur,

chlorine and nitrogen. Oxygen, the most abundant of these elements, unites with each of the others, forming a group of compounds called oxides.

Water is an oxide of hydrogen. Silica or quartz is an oxide of silicon. It is the hardest and most enduring of the rock forming minerals. It is the main ingredient of sand and sandstone rocks, and is abundant in granite rocks.

The oxide of silicon combined with the oxide of aluminum forms the silicate of aluminum or kaolin. The silicate of aluminum, combined either with the silicate of potassium, the silicate of sodium, or the silicate of calcium, or with either two of these substances, forms a group of rock forming minerals called feldspars. They enter into the composition of lavas, granites, shales, slates and clays. The oxide of carbon combined with the oxide of calcium forms calcium carbonate, or calcite. It is the basis of many of the limestones and marbles, so abundant in the crust of the earth. Magnesium limestones are a combination of calcium and magnesium carbonates called dolomite. The oxides of iron, called hematite, and magnetite are abundant minerals that constitute the greater part of the iron ores. Calcium sulphate or gypsum, calcium phosphate, sodium chloride or common salt, graphite and the various forms of coal are important minerals.

It is supposed that the materials which make up the earth were once a mass of intensely heated gases, and that in time the greater part became a molten liquid, and that finally the outer portions of the liquid mass became solid. As the mass cooled irregular contractions gave rise to broad, low swells, and wide, shallow depressions, the elevations gradually becoming continents and the depressions, becoming deeper, formed the ocean beds.

The first elevations of the continent doubtless included the area now known as Vigo County. The rocks of these primal elevations were probably a somewhat homogeneous mass of alkaline silicates, much like a bed of lava. There were no sandstones nor limestones, no shales nor granites, no iron ores nor coals, just a mass of materials from which these different kinds of rocks have been formed.

The ocean waters and the vapors of the atmosphere were intensely acid. As they and the slag-like crust reacted upon each other the air gradually became pure, the rocks were dissolved and broken down, the waters lost their acids and became charged with sodium chloride, calcium carbonate, and other compounds; silicates of aluminum, potassium, sodium, calcium and other materials of feldspars were formed and spread out over the ocean bed as sediments of clay, and alongside of, or mingled with these clay sediments were beds of sand composed of quartz and other materials of the disintegrated rocks. As the conditions became favorable the lower forms of vegetation, as algæ and seaweeds, appeared in the shallow coast

waters, becoming very abundant. The remains of this vegetation in many cases gave rise to carbonaceous sediments, possibly something like peat beds. Through the agency of this vegetation iron sediments in great quantities were formed.

Later, as animal life became abundant, lime sediments began to accumulate from the skeletons and shells of these lower forms of life. As these sediments thickened the lower portions under the influence of heat, moisture and pressure became rocks; sandstones, shales, shaly sandstones, coal, iron ore and limestones being examples. Thus for millions of years these sediments and rocks were forming on all sides of the central area which was continually rising, while the ocean beds with their load of sediments were continually settling. These processes do not seem to have been absolutely continuous, as there are evidences that in some cases, wide areas were raised above the sea, and for ages subjected to the action of eroding agents. Then they were again submerged and covered with sediments.

Finally a great change began, the central regions were depressed and the adjacent sediment receiving areas were raised above the sea. A broad area extending from the region of Lake Superior northeastward to Labrador and northwestward to the Arctic Ocean, was changed from the bed of the sea to the nucleus of a continent. At the same time extensive areas were elevated along the region of the Appalachian Mountains, including the Ozark region, and elevations were formed along the region of the Rocky Mountains.

These land masses formed the nucleus from which the continent has grown. They have furnished much of the material from which the rocks of the central areas have been formed.

Under the influence of the heat and pressure attending these changes of the earth's crust these early rocks became crystalline. The sandstones were changed to quartzites, the clays and shales to slates; the shaly sandstones and sandy shales to granites, gneisses, etc.; the coals to graphite; the iron sediments to iron ores; the limestones to crystalline limestones and marbles. These changes closed a period in the geological history of the earth which is called the *Archæan* or beginning age. The earlier rocks of this era are sometimes called Laurentian rocks, from their occurrence along the St. Lawrence River, while the later strata are known as Huronian or Algonkian rocks.

The Cambrian Era.—This era began with the formation of extensive sandstone strata along the borders of the Archæan lands. The Potsdam sandstones of New York and the pictured rocks of Lake Superior belong to this era. Whether these strata extended over the region of Indiana may not be positively known, but Professor Cubberley in the 18th Report of the Geology of Indiana, represents the deep wells at Indianapolis,

Richmond, Bloomington, Frankfort, South Bend and Connersville, as reaching the Potsdam sandstone.

Heavy beds of Magnesian limestone in Tennessee and Missouri belong to this era, but it is doubtful if they are represented in this region. The life of this era was abundant, the plants were algæ and seaweeds, the animals, members of the different orders of invertebrate life that live in the sea. No traces of land plants or animals have ever been found. So little is known that it is impossible to form any very definite idea of the conditions existing in this region during Cambrian times, but it is thought to have been the bed of a comparatively shallow sea over which sediments of sand and clay were deposited.

The Lower Silurian Era.—The characteristic rocks of this era are the calciferous sand rock, the Trenton limestone, the Utica and Hudson River or Cincinnati shales. The sand rock does not seem to be represented in Indiana, but the others are surface rocks in several counties of southeastern Indiana and are underlying rocks over the balance of the State. The life of this era as shown by its fossil remains was much like that of the Cambrian, but remains of insects and of fishes indicate considerable progress in the forms of life.

The limestones which make up the principal strata of this era in Indiana seem to have been formed in warm shallow coast waters, the land slowly but surely encroaching on the sea, as in the case of some parts of Florida and Cuba at the present time.

This era closed with the elevation of the Taconic system in the east and the Cincinnati arch in the central regions. The Cincinnati uplift extends from the region of Cincinnati northwesterly across Indiana and northerly through Ohio. It consists of many ridges or folds extending in various directions, which are important features in the geological formations of the State.

The Trenton limestone was originally simple corbonate of lime, but in same localities it has changed to a porous magnesian limestone, which has become a reservoir for mineral oil and natural gas.

The Upper Silurian Era.—The earliest rock of this era is the Medina sandstone, which does not seem to be represented in the central regions. Following this sandstone were the Niagara and Clinton limestones and shales, which extend over the greater part of Indiana. They are surface rocks in Wabash, Miami, Wells, Huntington, Adams, Grant, Blackford, Marion, Tipton, Clark and other counties of eastern Indiana. The life of this era was abundant. The Niagara and Clinton limestones are noted for the number and variety of their fossils. The life was much like that of the Lower Silurian but with more species of insects and fishes. During this era there seems to have been shallow seas with coral reefs and myriads of mollusks, brachiopods, crustaceans and similar forms of life. In some cases there seem to have been extensive mud flats and

marshes with turbid waters, so that the forms of life were limited in numbers. In some localities extensive beds of salt were deposited. Portions of the Niagara limestone near Chicago are said to be saturated with rock oil, but it is not generally an oil-producing rock.

The Devonian Era.—The rocks of this era found in Indiana are the Corniferous limestones and Genesee shales. They underlie the northern and western part of the State and are surface rocks in Jefferson, Rush, Jennings, Bartholomew, Decatur, Shelby, Johnson, Tippecanoe, Cass, Wabash, Clark and Floyd counties. In this era land plants, as lycopods, ferns and equisetæ, became abundant, and great fishes dominated the seas; but the conditions were specially favorable to the growth of corals, and the Corniferous limestone is a coral rock, showing that form of life to have been varied and abundant. But during the deposition of the shales the waters were turbid and the forms of life were few. The Corniferous limestone in some localities abounds in mineral oil, as in western Canada. A coarse, porous sandstone of the Upper Devonian is the chief source of the mineral oil and natural gas of Pennsylvania.

The Carbonic Era.—This era is divided into the Subcarboniferous, Carboniferous and Permian periods. The Permian is not represented in Indiana.

The Subcarboniferous Period.—The rocks of this period in Indiana are the sandstones and shales of the Knobstone group, the limestones and shales of the Keokuk group, the famous oölitic limestones, with the shales and other limestones of the St. Louis group, and lastly the sandstones, shales and limestones of the Chester group. The limestones of these groups abound in fossil crinoids, brachiopods and corals, and are often called crinoidal limestones. The famous crinoid beds of Crawfordsville belong to the Keokuk group of strata. These strata indicate shallow seas, sometimes clear and abounding with life, again turbid and nearly devoid of life. These are outcropping rocks in Washington, Orange, Crawford, Brown, Monroe, Harrison, Floyd, Lawrence, Owen, Morgan, Putnam, Benton, Hendricks, Montgomery, Tippecanoe, Perry, Jackson, White and Jasper counties.

The Carboniferous Period.—The rocks of this period in Indiana consist of 13 or 14 coal seams, with their associated sandstones, shales and limestones. These strata are surface rocks in Posey, Vanderburgh, Warrick, Spencer, Gibson, Pike, Dubois, Knox, Daviess, Martin, Sullivan, Greene, Clay, Vigo, Parke, Vermillion, Perry, Owen, Crawford, Fountain and Warren counties.

While carboniferous strata are found in the counties mentioned, the whole series does not occur in any one locality.

The basic rock of the coal measures is generally a coarse-grained sandstone, known as the millstone grit or conglomerate sandstone. This rock is distinct and well marked in Ohio and eastward, but it is often difficult

to identify in Indiana. The strata of this period are generally very irregular in their structure and composition, making it a difficult one to work out. In general, it must have been a period in which a great variety of conditions prevailed. The surface was subject to many oscillations. At times the surface of the country was an extensive swamp or morass, over which peat-like sediments were forming. Again the surface was submerged, and mud beds of fine clay were being deposited; or the currents were stronger, and beds of sand were formed; or the waters were clear and crinoids and mollusks abounded, and their remains soon began to form beds of lime sediments.

During the Carbonic era plants were the dominant forms of life. Ferns, equisetæ, lepidodendrids, sigillaria and similar plants were abundant, furnishing much of the material for the coal beds. Among animals, many new species of insects and some higher types of fishes appeared. In addition, amphibians became abundant and a few reptiles appeared.

The Carbonic era and Paleozoic time closed with the elevation of the greater part of the Appalachian Mountains and the raising of the central regions to a permanent position above the sea. The elevation of the central regions was accomplished without any profound disturbance of the strata in this portion of the valley.

There are no rocks in Vigo County or in Indiana belonging to the Triassic, Jurassic or Cretaceous periods. If any sediments were ever formed over this region during these periods they were entirely removed by subsequent erosion.

During the Triassic, Jurassic and Cretaceous periods, which together make up Mesozoic time, sandstone and limestone rocks were formed along the Atlantic coast and in the western mountain regions. There are also some shales and eruptive rocks belonging to these periods. During these periods reptiles became the dominant forms of life. They were numerous, and of large size, and existed in a great variety of forms. And during this time the first birds, the first mammals and the first of our common fishes appeared. Among plants the first palms, the first true pines, and the first angiosperms, like the maple, magnolia and willow, appeared.

During this era the central regions of the continent, covered with vegetation, were slowly wasting away by erosion.

Mesozoic time closed with the elevation of the greater part of the Rocky Mountain system and the raising of the western interior regions of the continent above the sea.

The Tertiary Era.—During this era fragile sandstones and limestones, with some shales, were deposited along the borders of the continent, and in numerous isolated salt-water lakes in the western regions. Certain gravels in southern Indiana may be Tertiary formations, but they are not

extensive and their relations are doubtful. Mammals and plants much like those of the present came to be the chief types of life. This portion of Indiana was doubtless covered with vegetation and was the home of many forms of animal life.

The old drainage channels are the only records of the work done during the millions of years that have elapsed since the coal strata were deposited.

These old channels in Vigo County are from 100 to 250 feet deep and occupy fully one-half the area of the county.

They furnish no data for even an approximate estimate of how much of the strata was carried away, but they do indicate that the erosion was very extensive.

The Tertiary era closed with great elevations in the western mountain regions, but with little disturbance in the eastern portions of the continent. Great elevations also took place in Europe and Asia.

The Quaternary Era.—This era begins with the *Glacial Period.* The increased elevation and the enlarged area of the continental surface which marked the close of the Tertiary era, seem to have been important factors in causing the frigid climate of the Glacial period.

This low temperature continued until the ice accumulating over northern regions spread out toward the south, at first following the valleys, then overriding the hills covered the whole area with a mantle of ice.

The ice with its load of clay, sand, gravel and boulders crept slowly over the land, and like a great rasp cut down the more prominent features of the landscape, polishing the rocky surfaces, driving before it all kinds of vegetable and animal life, scraping away the old soils and filling all the old valleys with boulder clay and other glacial debris. The ice reached almost to the Ohio River, crossing it for a few miles near Cincinnati.

When at last the severe temperatures moderated and the ice melted away, the new surface was for the most part a plain. The immense quantities of boulder clay, the glaciated bed rock, and glaciated boulders from the Laurentain and Huronian rocks show that the glacier or ice sheet was in force over Vigo County.

As the ice melted away the streams reopened some of the old channels and made some new ones, but the northern regions seemed to have been slowly depressed, so that the streams became sluggish, and the greater part of the glaciated area was covered with lakes and marshes, conditions similar to those of the Carbonic era. This period called the *Champlain Period* was closed by a slight elevation, which raised the interior region to its present altitude and slope; drainage systems were developed and the Recent or Present Period of the earth's history with its modern vegetation and mammalian life was inaugurated.

The following table is a conservative estimate of the age of the earth and of the relative length of the different eras. It was compiled from the writings of Professors James D. Dana and Charles Wolcott:

The Quaternary Era	1,000,000 years.
The Tertiary Era	2,000,000 "
The Cretaceous Period	3,000,000 "
The Jurassic and Triassic Periods	4,000,000 "
The Carbonic Era	2,400,000 "
The Devonian Era	2,000,000 "
The Upper Silurian Era	1,600,000 "
The Lower Silurian Era	6,000,000 "
The Cambrian Era	6,000,000 "
The Later Archean Era	18,000,000 "
The Early Archean Era	18,000,000 "

THE STRATA OF VIGO COUNTY.

The strata which outcrop in the county or are easily reached by mining shafts belong to the Carboniferous period. These strata consist of coals, sandstones, shales, sandy shales and limestones. Each stratum varies in composition and thickness, and those near the surface were extentively eroded and furrowed with broad and deep channels during the millions of years that measure mesozoic and cenozoic times. At the close of the Glacial period these valleys were filled with boulder clay, and in many cases the hills were covered with a thick mantle of the same material. By subsequent erosion much of the boulder clay was carried away, and some portions replaced by sand and gravel. These circumstances make it difficult to trace the upper strata with any degree of certainty.

The strata of the other periods, down to and perhaps including the Huronian, lie in order below, but the records of the deep wells that have been drilled in the county are somewhat contradictory, and there is no very definite knowledge of such lower strata. The strata generally dip gently toward the west and perhaps toward the south, the general dip being often obscured by local variations which are often quite abrupt. On account of the westerly dip of the rocks of Vigo County the uppermost strata are on the west of the river. The following is a somewhat generalized section of the strata of the county:

Surface soil and subsoil clays	10 feet.
Boulder clay, or hard pan	20 feet.
Shale, with some sandstone	50 feet.
Sandy shales and clay shales	25 feet.
Limestone, variable, sometimes shaly	1 foot.
Shale, laminated, friable	1 foot.
Coal, rider vein, No. 9 (?) Illinois section	1 foot.
Fire clay and shale with limestone seams	12 feet.

Limestone, sometimes stratified with shale	3	feet.
Shale, argillaceous, fine	30	feet.
Coal, "O" Indiana sec.; No. 8 (?) Illinois sec.	4	feet, 6 inches.
Fire clay and shale	10	feet.
Limestone, massive, sometimes flinty	3	feet.
Shale, gray or reddish	10	feet.
Limestone, flinty, sometimes massive	3	feet.
Sandstone, massive or shaly	15	feet.
Shale, argillaceous, with some iron stone	20	feet.
Coal "N" Indiana sec.; No. 7, Illinois sec	5	feet.
Fire clay and shale, sometimes sandstone	15	feet.
Limestone, often flinty	3	feet.
Shale, black, slaty bituminous	5	feet.
Coal, "M" Indiana; No. 6 Illinois	4	feet.
Fire clay and shale	3	feet.
Sandstone, friable	40	feet.
Coal "L" Indiana; No. 5 Illinois	6	feet.
Fire clay and shale	20	feet.
Coal, outcrop on Otter Creek	2	feet.
Fire clay and shale	20	feet.
Coal, outcrop near county line	3	feet.
Fire clay and shale	15	feet.
Coal, upper vein at Caseyville, Clay County	3	feet.
Fire clay and shale	28	feet.
Coal, middle vein at Caseyville	3	feet, 6 inches.
Fire clay and shale	25	feet.
Coal, lower vein at Caseyville	3	feet, 6 inches.

The strata mentioned outcrop in the county, or are so near the surface that they could be easily reached if they were valuable.

In 1865 Chauncy Rose commenced drilling a well near the northwest corner of Eighth street and Wabash avenue, Terre Haute. The well was drilled for the purpose of obtaining fresh water, but after reaching bed rock at about 130 feet no fresh water was found. They found salt water in abundance. At 1,630 feet they found mineral oil, and at 1,793 feet they encountered a strong flow of sulphur water. Later a well was drilled on the northwest corner of Cherry and Eighth streets with about the same results as in the first case, and the sulphur water was used to supply a bath house. Later a third well was drilled near Wabash avenue, on the alley between Ninth and Tenth streets. This well is said to have yielded a strong show of mineral oil. Before 1870 a fourth well was drilled expressly for oil. It was located near the river, between Walnut and Poplar streets, Terre Haute. The following is a record of the strata passed through, as given in the Report of 1870 and again in the Report of 1875:

Section commencing about 20 feet above low water in the river:

	Ft.	In.	Total Ft.	Total In.
Sand and gravel	100	00	100	00
Soapstone	64	06	164	06
Coal "I"	6	02	170	08
Hard sandstone	2	03	172	11
Soapstone	10	00	182	11
Coal "G"	3	00	185	11
Soapstone	4	03	190	02
Gray sandstone	5	10	196	00
Blue soapstone		10	196	10
Gray sandstone	6	00	197	04
Blue soapstone	12	09	210	01
Soft black shale	6	00	216	01
Coal "F"		09	216	10
Soapstone	7	07	224	05
White sandstone (conglomerate?)	30	03	254	08
SALT WATER FROM THIS SANDSTONE.				
Blue Shale	7	02	261	10
Coal "B"	2	03	264	01
Black shale	10	00	274	01
White soapstone	3	00	277	01
Black shale	15	00	292	01
White soapstone	8	00	300	01
Black shale	3	03	303	04
Coal "A"	3	00	306	04
Soapstone	17	08	324	00
Sand rock	3	00	327	00
Soapstone	20	00	347	00
Sand rock	10	00	357	00
Blue shale	22	00	379	00
Limestone	2	00	381	00
Blue shale	31	00	412	00
Light shale	5	00	417	00
Blue shale	60	00	477	00
Sandstone	7	00	484	00
Blue shale	24	00	508	00
Sandstone	3	00	511	00
White shale	10	00	521	00
Blue shale	147	00	668	00
Hard gritty slate rock	11	07	679	07
Hard gray sandstone	14	05	694	00
Hard limestone	11	00	705	00
White limestone	24	00	729	00
Gray limestone	2	00	731	00
Limestone	14	00	745	00
White limestone	82	00	827	00
Soapstone	3	00	830	00
Brown limestone	35	00	865	00

	Ft.	In.	Total Ft.	In.
Soapstone	5	50	870	00
Lime rock	9	00	879	00
Soapstone	6	00	885	00
White limestone	7	00	892	00
Soapstone or gypsum?	2	00	894	00
White limestone	21	00	915	00
Gray limestone	5	00	920	00
Limestone and soapstone	5	00	925	00
Gray limestone	5	00	930	00
White limestone	15	00	945	00
Fine blue limestone	2	00	947	00
STRONG SULPHUR WATER.				
Dark gray limestone and flint	73	00	1,020	00
Light gray limestone	7	00	1,027	00
Blue gray limestone	7	00	1,034	00
Soapstone (fire clay)	26	00	1,060	00
Gray limestone	24	00	1,084	00
Gray sandstone	3	00	1,087	00
Soapstone (fire clay)	5	00	1,092	00
Quartz and shale, mixed	166	00	1,258	00
Quartz, slate and soapstone	3	00	1,261	00
Slate rock	21	00	1,282	00
Soapstone	33	00	1,315	00
Slate rock	7	00	1,322	00
Soapstone	235	00	1,557	00
STRONG SALT WATER AT 1,557 FEET.				
Soapstone and sandstone	10	00	1,567	00
Fine sandstone	15	00	1,582	00
Blue soapstone	40	00	1,622	00
Black shale	15	40	1,637	00
Red shale	5	00	1,642	00
OIL.				
Black shale	15	00	1,657	00
OIL.				
Lime rock	5	00	1,662	00
Black shale	5	00	1,667	00
OIL.				
Gray lime rock—OIL NEAR THE TOP	149	00	1,816	00
SULPHUR WATER AT ABOUT 1,800 FEET.				
Gray sand rock	23	00	1,839	00
Lime rock	73	04	1,912	04
SULPHUR WATER AT 1,840 AND 1,912 FEET.				

Professor Cox says that "experienced borers were employed, and the record of the strata passed through may be relied upon as accurate. The record has been carefully made, and each layer of rock tested to determine its character, consequently the sandstones are correctly placed."

Later the gas company drilled a well for gas on the bank of the river, near the foot of Swan street, Terre Haute. The record of this well, kept by Martin N. Diall, superintendent, is as follows:

	Ft.	Total Ft.
Sand and gravel, sandstone, shale and limestone...	1,110	1,110
Limestone	450	1,560
Shale	50	1,610
Limestone	3	1,613
To Oil Sands and Oil.		
Limestone	967	2,580
Shale	100	2,680
Limestone (perhaps Trenton)	250	2,930

Some of the wells drilled for water yielded oil, and some gas, but no measures were taken to promote the flow of either, and the well that seems to have furnished the most oil was plugged up and the site is now covered with buildings. The wells drilled for oil and gas yield an abundance of salt water and sulphur water, but no oil and but little gas.

In 1888 a wave of oil excitement reached Terre Haute and several wells were drilled for oil or gas. The records of the strata passed through in the drilling vary widely in detail, but agree in a general way, so that the ideas gained from a study of several different records will give a better knowledge of the deep strata of Vigo County than could be gained from one record.

The following records have been reduced to the level of low water in the river by subtracting fifty feet, as they all commenced at about that elevation above the river.

SECTION OF THE KINSER WELL.

Located between Fourteenth and Fifteenth streets just east of the center of section 22–12–9, near Liberty avenue.

	Ft.	In.	Total. Ft.	In.
Soil, gravel and sand	130	00	80	00
Shale or soapstone	70	00	150	00
Sandstone	10	00	160	00
Shale or soapstone	90	00	250	00
Sandstone	70	00	320	00
Shale or slate	130	00	450	00
Sandstone	140	00	590	00
Limestone	360	00	950	00
Limestone, with some shale	185	00	1,135	00
Limestone, with some quartz	85	00	1,220	00
Shale or soapstone	25	00	1,245	00
Limestone, with shale	225	00	1,470	00
Shale or soapstone	5	00	1,475	00
Sandstone or limestone	15	00	1,490	00
Shale or soapstone	138	00	1,628	00
Limestone or oil rock	20	00	1,648	00

A Little Oil Near the Surface of this Limestone.

SECTION OF THE BIG FOUR WELL,

In the northeast corner of the northwest quarter of Sec. 23–12–9:

	Ft.	In.	Total. Ft.	In.
Soil	6	00	....	..
Gravel	10	00	....	..
Sand	102	00	68	00
Shale or soapstone	117	00	185	00
Sandstone or limestone	2	00	187	00
Shale or soapstone	207	00	394	00
SALT WATER AT 265 FEET, 78 FEET BELOW TOP OF THIS SHALE.				
Limestone or sandstone	41	00	435	00
Shale or slate	50	00	485	00
Limestone or sandstone	12	00	497	00
Shale or slate	53	00	550	00
Sandstone	50	00	600	00
Limestone	600	00	1,200	00
Shale, with some limestone	190	00	1,390	00
Shale or slate	210	00	1,600	00
Limestone, oil rock, sulphur water	18	00	1,618	00

SECTION OF THE EXCHANGE WELL,

Situated a little west of the center of Sec. 22–12–9:

	Ft.	In.	Total. Ft.	In.
Soil and coarse gravel	80	00	30	00
Sand, fine	45	00	75	00
Shale and slate	65	00	140	00
COAL AT 88 FEET BELOW LOW WATER IN RIVER.				
Limestone	5	00	145	00
Shale	95	00	240	00
Limestone	10	00	250	00
Shale	40	00	290	00
Limestone	20	00	310	00
Shale or soapstone	210	00	520	00
Limestone	23	00	543	00
Shale	10	00	553	00
Limestone, hard and flinty	82	00	635	00
Shale	5	00	640	00
Limestone	160	00	800	00
Limestone, with some sand	70	00	870	00
Sandstone	30	00	900	00
Limestone	25	00	925	00
Sandstone	65	00	990	00
Limestone	30	00	1,020	00

Shale and slate	180	00	1,200	00
Sandstone, white	50	00	1,250	00
Sandstone and shale	50	00	1,300	00
Sandstone, white	150	00	1,450	00
Shale and slate	122	00	1,572	00
Limestone—oil rock	11	00	1,583	00

SHOW OF OIL AT 1,575 FEET, AND SULPHUR WATER AT 1,578 FEET.

SECTION OF THE ALDEN WELL,

On the northwest quarter of Sec. 23–12–9:

	Ft.	In.	Total. Ft.	In.
Sand and gravel	130	00	80	00
Shale or soapstone	110	00	190	00
Limestone	20	00	210	00
Shale or slate	300	00	510	00
Sandstone	10	00	520	00
Shale or slate	30	00	550	00
Sandstone	160	00	710	00
Limestone	300	00	1,010	00
Sandstone	90	00	1,100	00
Shale or slate, with some sand	132	00	1,232	00

SALT WATER IN THE SHALE AT 525 FEET, AND SALT WATER AND SULPHUR WATER BETWEEN 600 AND 700 FEET.

SECTION OF THE ELLIOTT WELL,

Located near the west line of Sec. 23 and Wabash avenue, Terre Haute:

	Ft.	In.	Total. Ft.	In.
Sand and gravel	128	00	78	00
Shale or soapstone	260	00	338	00
Sandstone	35	00	373	00
Limestone	40	00	413	00
Sandstone	98	00	511	00
Limestone	23	00	534	00
Sandstone	179	00	713	00
Shale or slate	110	00	823	00

In the *Smith Well*, near the southwest corner of Wabash avenue and Tenth street, S. W., S. W., sec. 22–12–9, they found shale at 112 feet, or at 62 feet below low water in the river, and the oil rock, limestone, at 1,632 feet, or at 1,582 feet below the river.

In the *Guarantee Well No. 3*, located between Eighth and Ninth streets, near Wabash avenue, the shale was found at 84 feet below low water, the first heavy limestone at 537 feet, top of the "oil sand" limestone at 1,569 feet, which rock was penetrated to 1,577 feet and 3 inches.

In the *Guarantee Well No. 4*, located on Tenth-and-a-Half street between Wabash avenue and Chestnut street, shale was found at 85 feet below low water, and a vein of coal six to seven feet thick at 305 feet, and blue lick or sulphur water at 1,590 feet.

In the *Guarantee Well No. 5*, near southwest corner South Fifth street and Farrington street, on the S. E. $\frac{1}{4}$, N. E. $\frac{1}{4}$ Sec. 28–12–9 shale was found at 106 feet below low water, and the top of the first limestone at 700 feet, the top of the "oil sand" limestone at about 1,700 feet, which was penetrated about 22 feet.

SECTION OF GUARANTEE WELL No. 6.

Northeast corner of Third and Mulberry streets, N. W. $\frac{1}{4}$, S. E. $\frac{1}{4}$ Sec. 21–12–9:

	Ft.	In.	Total. Ft.	In.
Soil, gravel and sand	128	00	78	00
Shale of varying shades	44	00	122	00
Coal, apparently good quality	5	00	127	00
Shales and sandstones	308	00	435	00
Limestone	40	00	475	00
Shales, blue and black	90	00	565	00
Limestone, varying somewhat	415	00	980	00
VERY STRONG SALT WATER AT 800 FEET.				
GAS STRONG BETWEEN 925 AND 935 FEET.				
Limestone, coarse	25	00	1,005	00
Shales, with some limestone	55	00	1,060	00
MORE GAS AT 1,060 FEET, PRESSURE VERY STRONG.				
Shales, with some limestone	40	00	1,100	00
MORE GAS AT 1,100 FEET.				
Limestone, with some shales	320	00	1,420	00
Shales	25	00	1,445	00
Limestone	9	00	1,454	00
Shale	43	00	1,497	00
Black shale with limestone shells	72	00	1,569	00
Coarse shales	9	00	1,578	00
Black limestone rock	20	00	1,598	00
BLUE LICK OR SULPHUR WATER AT 1,598 FEET.				

S. M. Reynolds, who superintended the drilling, says the Niagara limestone was well defined at the depth of 1,592 feet.

SECTION OF AN ARTESIAN WELL

Drilled at St. Mary's on the N. E. $\frac{1}{4}$, S. W. $\frac{1}{4}$ Sec. 6-12-9, by "The Sisters of Providence,'" the mouth of the well being about 100 feet above low water in the Wabash River:

	Ft.	In.	Total. Ft.	In.
Surface soil and yellow clay	20	00	....	..
Blue clay	55	00	....	...
Blue clay and quicksand	25	00	Low water.	
White shale	25	00	25	00
Coal, probably coal "N"	5	00	30	00
White shale—fire clay and shale	65	00	95	00
Coal, probably coal "M"	6	00	101	00
White shale—fire clay and shale	90	00	191	00
Coal, probably coal "L," the big vein	10	00	201	00
Fire clay and white shale	50	00	251	00
White sand rock	40	00	291	00
White shale	229	00	520	00
Sandstone	80	00	600	00
Limestone	490	00	1,090	00
FRESH WATER AT 730 FEET.				
Shale	50	00	1,140	00
Brown sandstone	20	00	1,160	00
White shale	250	00	1,410	00
Limestone and sandstone	180	00	1,590	00
Brown shale	115	00	1,705	00
Limestone	250	00	1,955	00

Sulphur water at 1,905 feet, but no show of oil or gas reported.

These different wells were drilled for water, oil or gas, and not for coal, nor for scientific purposes, consequently little attention was given to coal seams, or to an accurate record of the strata passed through.

The ordinary plunger drill was used so that the materials passed through in a distance of from five to seven feet were in general well pulverized and thoroughly mixed, making it difficult to mark the division between strata with accuracy, and often it was impossible to judge of the nature of the rock beyond the fact that it was easy or difficult to drill. The measurements were generally made by the rope, which, as the depth increased, became more and more uncertain. The strata are doubtless also more or less irregular, and mistakes may have been made, so that wide discrepancies are to be expected. Prof. E. T. Cox says that "in the record of the first well or bore given in the report of 1869 a number of limestones are represented in the upper part of the bore where none occur, and the lower carboniferous limestone, over three hundred feet thick, is almost entirely represented by shales." In the Seventh Report, after giving the record of the river well, Prof. E. T. Cox says: "It is of

course difficult to decide with certainty on the correlation of strata of coal when no other means are furnished than the simple record of a bore kept by parties who possess but a limited knowledge of the specific characters of rocks, even when exposed to view at the surface, much less when brought up by the sand pump in the condition of fine sediment." These remarks apply to many of the records made, but in some cases samples were preserved and measurements were made with a steel tape line, and in some cases the record keeper knew how to test for limestone. The wells all enter shale below the gravel and sand. This shale, having the irregularities of an old river bed, accounts in the main for the varying thickness of the gravel. The record of Guarantee No. 5 seems to indicate a dip of the strata toward the south. The river well shows shale 64 feet, coal 6 feet 2 inches, and shows four other veins within 125 feet. The Guarantee No. 6 shows shale 44 feet to coal 5 feet 8 inches, but shows no coal below. The Guarantee No. 4 shows coal 6 feet 120 feet below the top of the shale, but no coal below. Coal is mentioned in the record of the Alden well, but no definite record was made. I can find no other mention of coal, so that I think the details of the river well record concerning coal may be taken with grains of allowance. Nearly all the wells pass through a heavy bedded limestone, which they reach at different depths as follows:

The Guarantee No. 3 at	537 feet.
The Exchange Well at	553 "
The Guarantee Well No. 6 at	565 "
The Kinser Well at	590 "
The Big Four Well at	600 "
The well at St. Mary's at	600 "
The well by the river at	665 "
The Guarantee No. 5 at	700 "
The Alden Well at	710 "

This limestone varies from 300 to 500 feet in thickness and is often, perhaps generally, interstratified with shales, which practically divide it up into numerous strata, which doubtless represent the subcarboniferous limestones which are surface rocks in Putnam, Monroe and other counties to the east of the coal belt.

At about 200 feet, just below coal "F," the record of the river well shows 30 feet of sandstone, which Professor Cox thinks represents the millstone grit or conglomerate. The Kinser Well reaches 70 feet of sandstone, at 250 feet, but none of the other records show a corresponding sandstone, so that the millstone grit does not seem to be very well defined in this county.

The next place at which the records substantially agree is the top of the limestone in which oil was found. The records are as follows:

Guarantee Well No. 3, limestone, at	1,569 feet.
Exchange Well, limestone, at	1,572 "
Guarantee Well No. 6, limestone, at	1,578 "
The Smith Well, limestone, at	1,582 "
Guarantee Well No. 4, limestone, at	1,590 "
The Big Four Well, limestone, at	1,600 "
The Kinser Well, limestone, at	1,628 "
The Riverside Well, limestone, at	1,627 "

And all agree in recording something over 100 feet of shale as resting upon this limestone. To what age does this rock belong? This is confessedly a difficult question to answer. Some have thought it Trenton limestone, assigning the Niagara to a place about 700 feet below the surface. Some have called it corniferous limestone, and others think it is the Niagara limestone.

In the report of 1881 the general section of the State is given as follows:

Coal Measures	725 feet.
Sub-Carboniferous	680 "
Devonian	200 "
Silurian	3,000 "
Total	4,605 feet.

A careful study at the present time might suggest some changes in this section, yet it makes it almost certain that the limestone can not be the Trenton rock.

Professor E. P. Cubberly, in "Indiana's Structural Features as Revealed by the Drill," Eighteenth Report, pages 219 and 223, calls the shale Devonian and the limestone Niagara. The shales are undoubtedly Devonian, but it is not clear why the limestone may not as well be referred to the Corniferous as to the Niagara. The river well shows oil in the upper portion of a limestone 150 feet thick, then 23 feet of sandstone, then another limestone. The Gas Works well record shows continuous limestone from the oil horizon to 2,500 feet, and the Exchange well deepened to 1,800 shows continuous limestone.

The Corniferous limestone belongs and often occurs between the Devonian shales and the Niagara limestones, but it is sometimes absent. There are three records below the oil horizon, of these the gas well record is, I think, the most reliable. The balance of the evidence shows continuous limestone, and continuous limestone would, I think, indicate Niagara rock. Practically the question is not of much importance, as oil has been found in paying quantities in both the Corniferous and the Niagara limestones.

OIL.

On the 8th of May, 1888, mineral oil was reached in the Diall well, Guarantee No. 1. It is located on the alley between 9th and 10th streets and between Chestnut and Eagle streets. It came in a gusher, and it was a surprise. Oil flowed out over the whole region into the sewer and down to the river and its villainous odor filled the air for squares. The excitement was intense. Oil and gas companies were formed by dozens. Hundreds of localities were leased and soon a score of drills were pounding downward toward the oil-bearing rock. The Phenix well, between Mulberry and Eagle streets, reached the oil and has been a good well ever since. The Lewis well, Guarantee No. 3, between 8th and 9th streets near Wabash avenue yielded some oil, but most of the others got only salt water and blue lick or sulphur water. The Phenix well is now producing about 1,800 barrels of oil per month. The oil flows but slowly and the output is increased by continuous pumping. This seems necessary to keep back the water. The Guarantee No. 1 has been drowned out, but a few days or weeks of pumping would doubtless make it again an oil well as strong as ever.

The fact that even one well is now yielding oil, and has been a strong well for nearly eight years, is conclusive evidence of an oil field. But how extensive it is no one can tell. The Phenix well has been deepened a few feet from time to time for the purpose of facilitating the flow of the oil. Such a large product for so many years is a remarkable record among oil wells.

The longer this well continues to yield oil in abundance, the stronger grows the conviction that the oil field is of considerable extent. But where is it? The Diall well, Guarantee No. 1, on Nine-and-a-Half street near Chestnut; the Phenix well about 300 feet due south; the Lewis well, Guarantee No. 3, between Eighth and Ninth streets, near Wabash avenue, and the Rose well on Nine-and-a-Half street, near Wabash avenue, seem to be in the field. The Lewis and the Diall wells have each produced from 700 to 1,000 barrels of oil per month, and if pumped continuously would probably yield as much now as ever before. The Exchange well, about 500 feet east of the Diall well; the Guarantee No. 2, on Eighth street, about 1,000 feet north and a little west; the Smith well, due south near Wabash avenue, found only salt water and sulphur water. Nine or ten other wells in different directions from the producing wells, but at greater distances, found the sulphur water and not the oil. It hardly seems possible so small an area as that occupied by the producing wells could have supplied these wells for so many years. Mr. Diall suggests that these wells reached a small area of producing rock that is connected with a much

larger field by a narrow passage, but no one has any idea of the location of the larger field. The oil is generally found in or near anticlines. The records of the wells drilled give some indications of a slight anticline trending north and south, but slight differences in level and imperfect measurements make it impossible to establish or demonstrate an anticline with any degree of certainty. There are three well-marked anticlines in the southern portion of the county which might yield some oil if explored with a drill.

Natural Gas.—In each of the wells drilled more or less gas was found, in some cases under very strong pressure. In Guarantee No. 6 a strong flow of gas was met at 975 feet. The pressure was sufficient to throw out the whole column of salt water, and, when lighted, burned with a flame ten to twelve feet high. This pressure continued for several days. At the Bath House well, near the river, the gas was for a long time used as a fuel. In most cases the sulphur water flowed from the well. Before reaching gas, water stood in the wells at about the level of the river. In some cases, at least, the water began to flow after the gas was found, and many ascribe the flow of the water to the pressure of the gas, others think the water-flow was caused by hydrostatic pressure, possibly from the Great Lakes. Mr. S. M. Reynolds, who has given the matter considerable attention, thinks the water-flow is due to gas pressure.

THE OUTCROPPING STRATA OF VIGO COUNTY.

The uppermost rock stratum in Vigo County is a thick bed of bluish shale, which outcrops along Coal Creek and its branches in sections 14, 15 and 23, T. 13 N., R. 10 west, and along West Little Sugar Creek, in sections 9, 10 and 15, T. 12 N., R. 10 west. In each of these localities it forms cliffs from 20 to 40 feet high.

In Sugar Creek Township this shale weathers into concretionary masses. There is no appreciable difference in the hardness of the successive shells of the concretion, nor does the nucleus seem to be harder than the rest. P. J. Ryan sunk a well forty feet into this bed on N. E. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ section 9, 12–10. The material thrown out had the ordinary shale fracture, and in appearance was like the common shales of the coal measures. But after it had been exposed to the weather for several weeks every lump became a concretion, breaking up easily into spherical shells. The bed seems to be fine aluminous shale, growing a little sandy toward the surface, as shown in Mr. Ryan's well. Just north of the well I found some micaceous sandstone in a little creek bed, but I could get no idea of its thickness or extent. I think it is only a thin layer of no great extent, with shale above and below.

Along Coal Creek the shale on the weathered face has a jointed structure, and is a very fine quality of shale for manufacturing purposes. On section 15 there are some thin layers of sandstone in the shale, which one mile south, on sections 22 and 23, have thickened up into a bed of compact sandstone, from three feet to five feet in thickness. On the S. E. N. E. section 22, and near the middle of the N. W. ¼ section 23, this rock has been quarried to some extent for use in foundations for houses and barns in the neighborhood. Some has been used for bridge piers. Mr. H. T. Carson, who has done most of the quarrying, says the rock in some cases has stood well for forty years as foundation stones, but that it is too porous for bridge work. The compact stone is really of limited extent. Between the two quarries the bed consists of sandy shales. I could find no trace of this sandstone west of section 22 or east of section 23, and none north of section 15. None appears toward the south unless that found near Mr. Ryan's, on S. W., S. W., section 4, 12–10, may be an extension of the bed. On S. E., S. W., section 14, 13–10, I could find no trace of it in a high shale bluff. This body of sandstone seems worthy of mention, but whether it is entitled to be regarded as one of the strata of Vigo County is doubtful. Below the sandstone the shale is apparently the same as that above. The thickness of the bed along Sugar Creek is at least fifty feet, and on Coal Creek, including the sand, stone, it has the same thickness.

Along Ashmore Creek and its branches, on sections 30 and 31–11–10, and along Crooked Creek, on sections 17 and 20–11–10, in Clark County, Illinois, there is an outcrop of sandstone, limestone, shale and coal, as follows:

Sandstone, reddish, compact or shaly	50 ft. + or —
Sandstone, shaly, with thin partings of coal	2 ft.
Shale, gray, free from grit	2 ft.
Limestone, massive, many fossils	2 ft.
Shale, dark colored	2 ft.
Shale, slaty, splitting into broad sheets	2 ft. + or —
Coal, apparently of good quality	1 ft. 6 in.
Fire clay and shale	5 ft. + or —

Some of the limestone was clayey, but seemed to resist well the action of the atmosphere, weathering evenly on the outcrop. The slaty shale in some places was interstratified with thin layers of coal, and the layers were in many cases covered with gypsum crystals. The sandstone on Ashmore Creek forms cliffs of beautiful dark-brown stone, that is uniform in texture and color. The coal is called No. 10 in the Illinois section.* These strata rise rapidly toward the north and are not to any extent represented in our county, except the shale below the coal, which, I think,

*See Vol. VI, pages 18 and 19, of the Illinois Reports.

is the upper stratum of our county outcropping along Coal Creek and West Little Sugar Creek. These strata enable us to correlate the strata of Vigo County with those of Illinois.

In the bank of Coal Creek, on S. E., S. W., Sec. 14–13–10, below the shale there is a thin bed of limestone that varies in thickness and character. The strata in that locality are about as follows: Shale, 30 feet + or —; limestone, 6 inches; shale, somewhat slaty, 6 inches; coal, 1 foot 3 inches; fire clay and shale, 2 feet; a very white shale, free from grit and with the taste of alum, 2 feet; shales, seamed with limestone in various directions, 2 feet +.

The limestone above the coal was sometimes blue, compact and hard, but within a quarter of a mile it appeared like limestone nodules cemented with clay. In section 23, a half mile south, it was represented by a calcareous shale. The coal on section 23 is not more than six inches thick, but on N. E., S. W. section 24 it is about 1 foot 3 inches again. I did not find this vein anywhere outside the Coal Creek Valley, and whether it is a local vein of limited area or whether it represents the Illinois No. 9 I can not tell. It has been worked a little, both on sections 14 and 24, and the coal is said to be of good quality, but the vein is too thin for profitable working. The white shale that tasted of alum was peculiar and interesting. I have seen nothing else like it in the county. It seems to be of limited extent, but a little exploration might disclose it in large quantities.

On the N. E. quarter, N. W. quarter section 23–13–10, Messrs. Eddington and Vermillion have a coal shaft which passes through the following strata; commencing in the valley below the sandstone:

	Ft.	In.
Shale, light colored, fine quality	5	00
Limestone, impure and shaly	0	06
Coal, of inferior quality (Illinois No. 9)	0	08
Shale, of good quality	34	00
Limestone, clayey	8	00
Shale	34	00
Coal, Indiana "O," Illinois No. 8	4	08

This coal is the main vein in Fayette Township, along Coal Creek, and north to Brouilett's Creek. The strata above it, or between it and No. 9, vary somewhat, but in general are as given in the section of the shaft on section 23. Along Coal Creek, as shown in its banks and bed, the limestone is very irregular in bedding and character. In general it is interstratified with the shale sometimes in nodular masses of flinty limestone, sometimes shaly and jointed. But on the N. W. quarter, S. W. quarter, section 20, the limestone is close grained, compact, somewhat clayey and about 3 feet 6 inches thick. Along Coal Creek the shale, where free from limestone, is of the finest quality. On section 20 there is about 30

feet of shale between the limestone and the coal, while on the S. E. quarter, section 24, there is not more than 15 feet, the limestone being distributed throughout the middle two-thirds of the space between the coals. This shale, and sometimes the limestone, crops out along the streams northward into the valley of Brouilett's Creek.

Coal "O" varies from 3 feet to 5 feet in thickness. It has a roof of good solid shale. Between the shale and the coal there is from 8 to 12 inches of slate or bone coal which consists of layers of slate or shale and coal, the shale having a ribbed or striated appearance. The coal proper is solid without slate or dirt bands, and while there is some sulphur it usually occurs in such masses that it is easily removed. This crops out and has been mined on S. W. quarter Sec. 33–13–9; on N. W. quarter, N. E. quarter Sec. 32; on N. W. quarter Sec. 29; on S. E. quarter Sec. 24–13–10; on S. W. quarter Sec. 20–13–9, and at other points along Coal Creek and its tributaries. The mining has mostly been strip bank or slope mining. This vein has also been mined on S. E. quarter Sec. 17–13–9; on S. W. quarter Sec. 4–13–9, and on the N. E. quarter Sec. 6–13–9, and at several points along Brouilett's Creek and its branches just outside our county. The mining is on a limited scale and almost exclusively for local trade. There is a thin vein of coal outcropping near the center of section 23–12–10, and at other places in Sugar Creek Township. The miners call it the Rider vein. I think it probably is coal "O." It is seldom more than one foot in thickness, and while of good quality is of little economical importance.

Below coal "O" we find fire clay and shale, limestone, shale, sandstone and limestone, sandy shales and clay shales to coal "N." The fire clay and shale on Coal Creek and northward is from six to ten feet in thickness. Toward the south the variation in thickness is through a wider range. In every place that I have been able to examine this material it has been a fine clay shale free from grit. In a bluff of Coal Creek on the S. W., N. W., Sec. 28–12–9, in the lower part of this shale there is a thin layer of fine grained silicious rock about one foot in thickness. It is light brown in color and is traversed by tubes of varying size that possibly may have been worm tubes. It seems to be of limited extent. The limestone along Coal Creek and northward is flinty and nodular, often brittle, and breaking with a conchoidal fracture. It varies from one to two feet in thickness. On the S. half, S. E., Sec. 17–13–9 this limestone changes into a peculiar conglomerate mass of limestone, coal, kaolin, clay iron stone, occurring sometimes as pebbles, again as angular masses, and sometimes as a cement. In one locality this conglomerate seemed to pass into sandy shale filled with kaolin nodules. I did not find this peculiar conglomerate representing the limestone at any other locality west of the river. Toward the south this limestone becomes a hard, somewhat crystalline rock from two to three feet in thickness. It has

been quarried on sections 24 and 25–12–10, and quite extensively on N. W. quarter Sec. 15–11–10. It was used in the construction of the old National road, for bridge piers and road bed, and has been used for foundations and riprapping, for which it seems well adapted. It contains a few fossils, but the rock is so hard that it is seldom possible to get out a fossil in good condition.

The shale below this limestone is from three to twelve feet thick, resting usually on limestone below. This is a fine clay shale, generally free from impurity of any kind, but sometimes it is seamed with limestone, sometimes it is reddish or bluish, sometimes white or gray.

In Fayette township, where examined, it was of a light color. On Sec. 23–12–10, and on the S. W. Sec. 11–11–10, it is light colored, but on S. half Sec. 25–12–10, and on the E. half Sec. 15–11–10, and at other places it is highly colored, but always of a fine quality. The shale from H. T. Thorp's place, Sec. 23–12–10, belongs to this bed. It is mentioned in the 20th Report Indiana Geol. Surv. page 73. Near the center of Sec. 23 the two limestones outcrop in the bank of Sugar Creek, and are separated by twelve feet of this valuable shale. But about a quarter of a mile west the limestones outcrop again with not more than three feet of shale between them, and this containing quantities of limestone, generally in boulders. The boulders were of blue fossiliferous limestone, the fossils prominent on the eroded surfaces. The boulders contained masses of calcite, which often formed beautiful crystalline cavities.

The lower limestone varies greatly. In the southern part of the county it is seldom as thick and never of as good quality as the upper one and is called by the miners "bastard limestone." As it forms a thin layer over the sandstone below, they sometimes fail to recognize it as limestone. On Secs. 5, 7 and 18–12–9, both limestones become nodular and irregular in stratification, but on Sec. 33–13–9 the bedding becomes distinct, but the upper is nodular and flinty, while the lower is tough and compact, forming a good building stone. It has been quarried on S. W. Sec. 33 and on N. W. Sec. 28 and on S. W. Sec. 16–13–9. In some places it forms distinct strata, while in others it occurs as great lenticular masses in the sandstone, which usually lies below it.

The sandstone below this limestone is sometimes massive and of uniform texture, forming a good quarry stone, as on S. W. 28, N. W. 28, and S. W. 16–13–9, but toward the south it is fragile and shaly. It merges into a sandy shale which sometimes has a peculiar wavy structure. These sandy shales merge into fine clay shales below, so that it is difficult to say how much there is of either of the three strata below the limestone. Perhaps the following section on Sec. 24–12–10 will be about an average. Sandstone, 12 feet; sandy shale, 10 feet; clay shale, 30 feet. This sandstone and the underlying shales are represented on the east side of the river forming the upper strata over much of the uplands. But on the

east side there is less of the sandy shale, the division between the sandstone and clay shale being usually quite distinct. They occur in the southwest of Pierson Township, where the shale disappears so that the sandstone rests on coal "N." In the northwest of Pierson and northeast of Linton Townships, both strata are well developed, the sandstone with some shale bands being thirty feet in thickness and the shale fully as thick. They occur in Riley, Lost Creek and Nevins Townships in the higher elevations. The sandstone and shale outcropping along Stone Quarry Creek belong to these strata, and occasional masses of limestone in the sandstone seem to represent the overlying limestone. I also think the rocks along the old canal near the town of Lockport belong to these strata. The limestone, sandstone and shale on the N. W. quarter Sec. 2 of Riley Township and the sandstone on S. E. quarter Sec. 26 of Lost Creek Township, probably lie just above coal "N," and the same seems to be true of the sandstone and shale on the N. half of Sec. 13, of Honey Creek Township. The following is a section of the Burke Bros. shaft on the S. E. quarter S. W. quarter Sec. 21–12–8, Lost Creek Township.

Surface soil, white and yellow clay	10 feet.
Hard pan or conglomerate	55 feet.
Sand rock, shaly	25 feet.
Coal "N"	5 feet.

A section of the Lochner Coal Company's shaft on N. W. quarter section 14, near Seelyville, is as follows.

Surface soil, white and yellow clay	13 feet.
Hard pan, boulder clay	4 feet.
Sandstone, with black seams	22 feet.
Coal "N"	3 feet.

A portion of the sandstone was like the conglomerate found on S. W. quarter Sec. 16–13–9, west of the river, and the same was found in the Soules Bros. shaft on N. W., S. W. Sec. 21–12–8. In the Soules shaft a little limestone was found. A portion of what the Burke Bros. called hardpan may have been boulder clay, but there was a large mass of the conglomerate, as their dump pile fully proves. If the conglomerate takes the place of limestone, as on S. E. quarter Sec. 18–13–9, then in these shafts the limestone and sandstone are represented but not the fine clay shale. The sandstone and shale occur in the hills about Grant, in Nevins Township, and perhaps in other localities.

Coal "N" was called coal "N" east of the river and coal "L" west of the river by Prof. E. T. Cox in his report of 1870. The coal and attendant strata have been cut out by the river for a distance of about five miles, and it is a matter of considerable difficulty to correlate strata across such a wide gap. Coal "N" is known as the "Sugar Creek Coal." It outcrops at about high water mark at the base of the bluff west of Macksville, and has been mined in strip bank and shaft at many

places on sections 6, 7, 8, 18 and 19, township 12 N., range 9 W., and on sections 13, 24 and 25, township 12 N., range 10 W. On the sections mentioned the coal is substantially horizontal from north to south, dipping slightly toward the west. From this region it dips to the north so that it is in the bed of the river at Durkey's Ferry. Then, judging from strata above, it runs nearly horizontal again till near the county line, when it rises rapidly toward the north and is found high in the hills three miles north of the county. South of sections 19 and 25 coal "N" dips to the south with the other strata, and does not come to the surface again in our county west of the river.

East of the river coal "N" has been mined in several localities. Commencing on the south it is mined on the S. W quarter section 32 of Pierson Township and on section 5, just south, in Sullivan county. The section of B. W. Forbes' shaft on S. W. section 32 is as follows:

Soil and subsoil clay	5 ft. + or —
Sandstone, mostly compact	40 ft.
Shale, with lime nodules	0 ft. 6 in.
Coal "N"	4 ft. 6 in.
Fire clay and shale	7 ft. + or —

The section at the Sharp Bros.' shaft, about a quarter of a mile south, is as follows:

Soil and subsoil clay	3 ft. + or —
Sandstone, massive	26 ft.
Shale—fine, light colored clay shale	14 ft.
Coal "N"	4 ft. 8 in.
Fire clay and shale	7 ft. + or —

The sandstone in each case is generally reddish brown and quite uniform in texture, but is easily crushed. It would make a beautiful building stone, but it is hardly firm enough for that purpose. An interesting fact shown by these sections is the total disappearance of fourteen feet of shale within a quarter of a mile.

Mr. Forbes tells me that while there is a little shale at the shaft in the mine, the sandstone generally lies upon the coal, forming the roof. The sandstone contains some coal fossils, and the shale next the coal is rich in fossil plants. This coal is found at Hartford, near the center of section 14, Linton Township, and along Russel's Run, on section 1, of the same township. Coal has been mined in this locality for many years. A section of Isaac Hipple's shaft on the N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ section 1–10—9, is as follows: Soil, 3 feet; sandstone, 10 feet; shale, 17 feet; coal, 3 feet. The shaft being in a little valley, shows only a portion of the sandstone. The shale just above the coal abounds with fossils, and shows numerous examples of slickensides. In this mine the coal dips to the south about 1 foot in 20 feet, but is nearly horizontal east and west. But about 200 yards east of the mine, in the east bank of the run, the coal begins to dip

rapidly toward the east, and is next found rising rapidly toward the north in the bed of the south branch of Honey Creek, on section 31, 11–8, about a mile and a half northwest and 50 feet below the coal in Hipple's mine. The coal on section 31 is about 2 feet, 6 inches in thickness, and has been mined in strip bank, but not extensively. The fossils in the shale and the slickensides in shale and coal are part of the evidence that the coal at Hipple's and on section 31 are the same, although for a long time I thought the balance of evidence was on the side of two distinct veins.

The shale overlying this coal outcrops in great cliffs along the south branch of Honey Creek for a distance of about four miles. On section 31 there are in it ironstone bands two to three inches in thickness and many ironstone nodules, but the bands thin out toward the north and south and finally disappear along with most of the nodules. North of section 31 this coal continues to rise for a short distance, then, changing direction, dips toward the north and does not appear again in form for economical mining till we reach the mines of the Burke Bros. and Soules Bros. on section 21 in Lost Creek Township.

Coal "N" occurs near Lockport in Riley Township; is some 30 feet below the bed of Stone Quarry Creek on Sec. 11–11–8, and is about the same distance below the bed of the creek on S. E. $\frac{1}{4}$ Sec. 26–12–8. It outcrops on the S. E. $\frac{1}{4}$, Sec. 14, and at different places on Sec. 12 of Lost Creek Township. Some of the earliest coal mining in Vigo County was from coal "N," on S. E. $\frac{1}{4}$, N. E. $\frac{1}{4}$, Sec. 16–12–8, by Alexander McPherson. In Lost Creek the shale that is so heavy over coal "N" in Linton, Pierson, Honey Creek and Riley townships has disappeared, and the sandstone in general lies on the coal, forming the roof. In a slope mine on Sec. 12 there is a layer of flattened clay stones, cemented together by reddish sandstone, just over the coal. The stones are seldom more than one inch thick or more than four inches broad. In the mines on Sec. 21 coal "N" is about five feet thick, but on sections 12 and 14 it is not more than three feet. In the mines on Sec. 21, where the vein is thickest, there is a thin dirt or slate band near the middle of the bed, which is not ordinarily found where the bed is thinner. Coal has been mined from this vein on Sec. 17–13–8 and at other places, but there is no extensive mining from this vein in Otter Creek or Nevins townships. The lower five or six feet of the shale above coal "N" on Sec. 17 is slaty in texture and highly bituminous. Coal "N" varies considerably in thickness and, possibly, in quality. On the east side of the river so much of it has been cut out by erosion that only comparatively small areas of coal occur, and exposure along the outcrops for centuries must have modified to some extent the character of the coal.

In the report of 1875 an analysis of coal from McPherson's mine, on Sec. 16–12–8, is as follows:

Fixed carbon	56.50	
Gas	37.00	
Water	2.50	
Ash, white	4.00	
		100.00
Coke	60.50	
Heat units	7,959.	
Specific gravity	1.239	
Weight of one cubic foot	77.43	

An analysis of coal "N" from Hartford shows:

Fixed carbon	49.00	
Gas	41.00	
Water	2.50	
Ash, white	7.50	
		100.00
Coke	56.50	
Heat units	7,721.	
Specific gravity	1.237	
Weight of one cubic foot	77.31	

West of the river the vein is usually thicker, but generally solid coal from the slate or bone coal above to the fire clay below. There is, perhaps, more pyrites in the vein on the west, but it is easily removed, so that as it comes to market the coal seems to be much the same in quality, whether from the east or west.

An analysis of coal "N" from a shaft near the railroad, on Sec. 7–12–9, is as follows:

Fixed carbon	47.50	
Gas	44.50	
Water	4.50	
Ash, white	3.50	
		100.00
Coke	51.00	
Heat units	7921.	
Specific gravity	1.210	
Weight of one cubic foot	75.62	

The fire clay, sandstone, shale and limestone between coals "N" and "M" are, in general, thin strata that do not require more than a passing notice.

Below coal "N" we find the following strata, as shown by the section of a shaft on N. E. quarter, S. E. quarter, section 17, township 11 north, range 8 west:

	Ft.	In.
Coal "N"	3	07
Fire clay	1	00
Sandstone, white	6	00
Shale, black bituminous	1	07
Limestone	6	00
Shale, bituminous, slaty	4 to 6	00
Coal "M"	5	04

The section in the Lochner Coal Company's shaft near Seeleyville is as follows:

	Ft.	In.
Coal "N"	3	00
Fire clay	2	00
Shale, light gray	16	00
Shale, dark colored	10	00
Limestone	0	08
Shale, dark colored, slaty	4	04
Coal "M"	0	02

Coal "M" is a good strong vein in Vermillion County and in Sullivan County, but is not a very important vein in Vigo County. It crops out in several places east of the river, but nowhere appears at the surface west of the river. Coal "M" is the upper vein at Clinton, where it is five feet thick. A section of the artesian well near St. Mary's shows: Coal "N" 5 feet, fire clay, white shale and soapstone 65 feet. Coal "M" 6 feet. A hole drilled by the Terre Haute Brick and Pipe Company showed "M" to be about the same distance below coal "N." No shaft has been sunk to this vein west of the river, so that we can know but little about it. Its character at Clinton and the section of the St. Mary's well lead us to expect a good strong vein underlying coal "N" west of the river.

East of the river we find coal "M" in the bank of Prairie Creek, on N. W. quarter, section 28–10–10, and on S. W. quarter, section 26–10–10 near Middletown. It also outcrops on the N. E., S. W., section 9–10–10, and at other places along the bluff, and also on S. E., S. W., section 10–10–10, about 30 feet above the outcrop on section 9. It occurs on S. W., section 23, at about the same level as on section 10. At neither of these places is the coal more than 18 inches in thickness, but in each locality it has been mined to some extent by stripping. It occurs on the N. W. quarter, section 30–10–9, with its attendant limestone and bituminous slaty shale. There are heavy banks of shale along a branch of Prairie Creek on S. half, section 17–10–9, which I can not locate with certainty, but think it is just below coal "N." The limestone in the bed of a branch of Prairie Creek, in sections 16 and 15, is probably the one above coal "M," which rises slowly toward the east. This rock disappears near the middle of section 15, and next appears in the bottom of the valley of South Honey Creek on the W. half, section 31, in Riley Township. From this place the rock with coal "M" rises to an outcrop on section 16, near Lockport. Coal "M" is mined on N. W., N. W., section 3–10–8, where the following strata are shown:

Soil and subsoil clay	18 feet.
Limestone, with numerous fossils	4 feet.
Shale, black bituminous, slaty	5 feet.
Coal "M"	3 feet.

In the shale above this coal there are many large limestone concretions or boulders. The coal found on the N. E. Sec. 33 and on E. ½ Sec. 36 of Pierson Township is, in my opinion, coal "M." But the coal on the E. ½ Sec. 24 may belong to coal "N." In general, coal "M" seems to be the surface vein throughout the southern tier of townships, coal "N" showing above it in two or three instances.

In the northern townships the vein is thinner than toward the south, so that the only locality east of the river where coal "M" is thick enough for successful mining, is near Lockport. On the N. W. ¼, S. W. ¼, Sec. 16–11–8, there is an outcrop of coal "M." The strata rise gradually toward the southeast, the outcrop showing along a little stream for a half mile or so in that direction, where they seem to run out. About 200 yards west of the outcrop, on N. E. ¼ Sec. 17, there is an old shaft in which coal "M" was reached at a depth of about 60 feet below the outcrop, and a drift was run from the shaft to the outcrop. From the shaft westerly the dip was more gradual. Toward the east the strata dip between 20 and 30 feet in a quarter of a mile, as shown by a drilling made while prospecting for a suitable place for a shaft. On the S. W. ¼. Sec. 9 there is evidence of a rapid rise of strata toward the east. We have here, then, a well-marked anticline, the western slope much more abrupt than the eastern. It probably extends southeasterly and then southerly as coal "M" on the N. W. ¼ of 3–10–8 is considerably higher than it is on the N. W. ¼, 6–10–8, showing a rise toward the east along the north part of Pierson Township. But the strata have been exposed at so few places that no very definite ideas can be formed as to their arrangement.

Coal "M," at the outcrop on Sec. 16, is about three feet. At the shaft it is five feet, and at the end of the west entry it is about six feet, showing a heavy body of coal in that direction.

West of the river, coal "M" is deep below the surface, but on Sec. 9–10–10 it is above high water, and on Sec. 10 it is higher still. But on Sec. 16–10–9, some five miles east, at a much lower level, the limestone above coal "M" rises slowly toward the east. When next seen it is deep in the valley of the south branch of Honey Creek, on Sec. 6 of Pierson Township. These facts seem to indicate that Johnson's Hill is part of an anticline and that the high lands near the northeast corner of Linton Township are part of another, and there is another near Lockport, so that a study of coal "M" shows, in the southern part of our county, at least three anticlines trending north and south. Coal "M" and its accompanying strata outcrop in several places north of Lockport, but I do not know of any place where it is mined at the present time. It is found in the south bank of Otter Creek, near Grant, on S. W. ¼, Sec. 27–13–8. In the report of 1875 it is stated that coal was mined

in this locality by stripping, and an analysis of the coal was given, as follows:

Fixed carbon	44.00	
Gas	44.00	
Water	3.50	
Ash—red	8.50	
		100.00
Coke	52.50	
Heat units	7,592.00	
Specific gravity	1.216	
Weight of one cubic foot	76.00 lbs.	

The numerous outcrops of rock in the southern part of the county can generally be referred to strata attending coal "M." The limestone sometimes reached in wells about Prairieton is probably the limestone above coal "M," and, in general, outcropping limestone east of the river lies just above this coal. The sandstones and shales are probably between coal "N" and the limestone. The sandstones, sandy shales, etc., found along the old canal in the west part of Sec. 15 and on Sec. 22–11–8 are probably between coals "N" and "M." The black, slaty, bituminous shale that everywhere overlies coal "M" always contains numerous limestone balls, usually somewhat flattened and varying greatly in size, sometimes as much as two feet in diameter. The shale is generally fossiliferous, and in many cases there are delicate crystals of calcium sulphate or gypsum between the layers.

The big vein of Vigo County, the one from which most coal is taken, is coal "L." It nowhere appears at the surface west of the river and no shaft has been sunk to it in Vigo County, so that little is known about it. But the vein east of the river is quite well known, especially in the northern portion of the county. A few sections from different localities will help us to understand the relations of the various strata. A somewhat generalized section from the top of Sandford's Hill, Sec. 1–10–9, to Sec. 16–11–8, is as follows:

Soil and subsoil clay	10 feet.
Sandstone, with bands of shale	30 feet.
Shale, sometimes with ironstones	20 feet.
Coal "N," 1 foot to 6 feet	4 feet.
Fire clay and shale	3 feet.
Sandstone, variable	10 feet.
Shale, dark colored	2 feet.
Limestone, fossiliferous, hard (3 feet to 6 feet)	4 feet.
Shale, black, bituminous slaty (4 feet to 6 feet)	5 feet.
Coal "M" (1 foot to 6 feet)	4 feet.
Fire clay and shale—in drill hole	40 feet.
Sandstone—hard rock in drill hole	53 feet.
Coal and shale bands—"L" in drill hole	7 feet.
Total	192 feet.

The Lochner Coal Company's shaft on N. W. ¼ section 14–12–8, near Seeleyville, shows the following sections:

		Ft.	In.
1.	Soil and subsoil clays	13	00
2.	Hard pan, boulder clay	4	00
3.	Sandstone with black seams and fossils	22	00
4.	Coal "N"	3	00
5.	Fire clay	2	00
6.	Shale, light colored	16	00
7.	Shale, bituminous, slaty	10	00
8.	Limestone, some fossils	0	08
9.	Shale, black, some fossils	4	04
10.	Coal "M"	0	02
11.	Fire clay	3	00
12.	Sand rock, white silicious	44	00
13.	Coal "L," with slate band in center	6	00
14.	Fire clay and sandstone	4	00
	Total	132	02

The shaft of the Ray mine on the N. E. ¼ section 14–12–8, shows the following section:

	Ft.	In.
Soil and subsoil clays	14	00
Quick sand	7	00
Hard pan, boulder clay	34	00
Gravel	7	00
Sandstone, shaly	41	00
Slate, or sandy shale	1	00
Coal "L" upper portion	2	00
Clay or shale dirt band	0	02
Coal "L" middle portion	1	06
Clay or shale, dirt band and iron stone	0	04
Coal "L," lower portion	3	00
Fire clay and shale	6 + or —	
Total	107	00

The shaft of the Grant Coal Mining Company, just south of the center of section 27–13–8, in the valley of Otter Creek, shows the following section:

Soil, surface clay	3 feet.
Sandstone, sometimes shaly	20 feet.
Shale, light colored	4 feet.
Coal "L," 5 feet to 7 feet	6 feet.
Fire clay and shale	5 feet + or —
Total	38 feet.

There are several mines along the valley of Otter Creek, east of this shaft, which show about the same thickness of coal, with the clay shale and the sandstone above. At Fontanet, on section 13–13–8, the coal is near the surface in the valley of the creek. On section

tion 12, at the Union Shaft of the Coal Bluff Mining Company, the coal is about 100 feet deep. In this mine, in some cases, the roof is of boulder clay and sometimes rock, and sections on the same 40-acre tract vary widely, according to the thickness of the hard pan. A drill hole on section 12 shows as follows:

	Ft.	In.
Surface soil and sand	26	00
Shale, or soapstone	8	00
Shale, somewhat slaty	20	00
Coal, perhaps coal "M"	1	06
Fire clay	5	06
Sandstone	8	00
Shale, dark colored	9	00
Coal, "L"	6	06
Fire clay	1 + or —	
Total	85	06

Another on the same section shows:

	Ft.	In.
Surface soil and sand	37	00
Hard pan, boulder clay	74	00
Slate or shale, black	7	06
Coal and slate	2	00
Slate or shale, black	1	06
Fire clay and black slate	12	00
Total	134	06

In this case coal "L" and strata above had been cut out by erosion.

At Rosedale, in Parke County, about one mile north of the Vigo County line, and northward to Coxville, coal "L" has been mined extensively. Above it is the valuable glass sand of Coxville and vicinity.

At Lyford near the river, about three miles north of the county line, the section of a coal shaft is given as follows:

	Ft.	In.
Soil, surface sands and clay	10 + or —	
Coal, little vein	3	00
Fire clay and shale	5	00
Sandstone	12	00
Gray shale, some dark	35	00
Limestone, 8 inches; coal, 4 inches	1	00
Fire clay and shale	4	00
Sand rock	5	00
Shale, dark and light	12	00
Sandstone	12	00
Shale	5	00
Coal "L" with dirt band	6	06
Fire clay	2 + or —	
Total	112	06

At Clinton, Vermillion County, across the river from Lyford, the Buckeye Shaft, sunk by Dr. Samuel McClelland, shows the following below the upper vein supposed to be coal "M"?

	Ft.	In.
Shale, black, bituminous, slaty	3	00
Coal "M," outcropping	5	00
Fire clay and shale	3	00
Sandstone	20	00
Shale, light colored	20	00
Shale, sandy	13	00
Shale, slaty and brown with iron stones	6	00
Coal, little vein	1	00
Fire clay and sandy shale	8	00
Coal	1	08
Fire clay and shale	6	08
Coal	0	09
Shale, some sandy, varying in color	48	06
Coal	1	08
Fire clay and sandy shale	13	03
Coal, the lower vein "L"	5	10
Fire clay and sandy shale	3	06
Coal	1	10
Fire clay and sandy shale	8	00
Total	170	08

On William Morey's place, in Brouilett's Creek valley, just south of the county line, a drill hole which commences about 25 feet above low water in the Wabash, shows the following section:

	Ft.	In.
Surface soil, sand and gravel	4	00
Shale	50	00
Sand rock	1	08
Coal	3	06
Fire clay and sandy shale	12	00
Black rock and gray slate	5	00
Coal	4	09
Iron band and black slate	2	02
Coal	3	11
Fire clay	3	00
Limestone	9	06
Slate, gray	10	06
Sandy shale and sandstone	34	00
Iron band and gray slate	5	04
Coal	1	06
Shale and iron band	10	00
Sandy shale and iron band	12	04
Sandstone	14	00
Gray slate	2	00
Coal (probably coal "L")	6	06
Total	195	08

It is difficult to correlate this section with the one at Clinton, but I think it starts just below coal "M" and shows a thickening of the little veins shown in the Clinton section.

An artesian well drilled on the W. ½, S. W. ¼, sec. 6–12–9, shows the following section:

Soil and subsoil, yellow clay	20 feet.
Blue clay and quicksand	80 feet.
Shale, light colored	25 feet.
Coal "N"	5 feet.
Fire clay, white shale and soapstone	65 feet.
Coal "M"	6 feet.
Fire clay, white shale and soapstone	90 feet.
Coal "L"	10 feet.
Fire clay, white shale and soapstone	50 feet.
Sand rock, white	40 feet.
Total	391 feet.

Coal "L" and its accompanying strata outcrop at several places in the valleys of Nevins Township, but generally they are below the surface. The sandstone which occupies nearly all the space between coals "M" and "L" at Seeleyville varies somewhat in thickness and structure. In general, it is a coarse-grained siliceous sandstone, sometimes massive, sometimes shaly. It crumbles easily, even after it has been exposed to the air for some time, and would hardly be valuable as a building stone. At Coxville, in Parke County, where it forms cliffs along Raccoon Creek, it yields a valuable glass sand and is extensively quarried for this purpose. There are no outcrops in Vigo County as extensive as that at Coxville, but along the Otter creeks in Nevins Township there are ledges of stone that seem to be quite as good as that at Coxville. The rock at Seeleyville seems to be much the same as that at Coxville, except that it is uniformly white, while that at Coxville is streaked or mottled with red. The shale that generally lies between the sandstone and coal "L" is seldom very thick, and I found no extensive outcrop of it.

Coal "L" varies in thickness from five feet to ten feet, with a quite constant average of six feet. Its "trade mark," as J. Smith Talley calls it, is a shale or dirt band which divides the vein into two parts. The upper part is generally from three feet to three feet six inches in thickness, seldom varying much. The lower part is usually about three feet thick, but it varies widely; in fact, the variations in the thickness of coal "L" are usually confined to the lower part. Sometimes there is a thin iron band about 15 to 18 inches below the top of the upper part of the vein, but this is by no means constant. In some cases there are two clay bands, as shown in the section of coal on N. W., 30–13–7:

	Ft.	In.
Upper coal	3	06
Slate or dirt band	0	0½
Coal, middle	0	05
Slate or dirt band	0	0½
Coal, lower	2	06
Dead coal with sulphur	0	03

Coal "L" has been mined only in Lost Creek, Otter Creek and Nevins Townships. It not only exists in large quantities, but it is good coal, as good as either coals "N" or "M." An analysis of coal "L" taken from the old mine at Seeleyville is given in the report of 1875 as follows:

	Upper Part.	Lower Part.
Fixed carbon	48.00	50.00
Gas	45.00	43.50
Water	3.50	3.00
Ash, white	3.50	3.50
	100.00	100.00
Coke	51.50	53.50
Heat units	80.07	80.31
Specific gravity	1.211	1.250
Weight of one cubic foot	75.68	78.12

An analysis of coal that represented the average output of "L" in the Ray mine at Seeleyville, made by Prof. W. A Noyes, is as follows:*

	Per Cent.
Total combustible matter	84.46
Volatile combustible matter	40.25
Fixed carbon	44.21
Moisture	7.57
Ash	7.97
Sulphur	4.01
The calculated heating effect per kilogram, in calories	6,656 calories.
Evaporative effect, per pound, of coal	12.4 lbs. water.

The report of 1875 says one pound of coal "L" will convert 12.31 pounds of water from 0°C into steam at 150° C. It is an excellent coal and possesses a high evaporative value.

The uniformity in thickness of coal "L" toward the north, and the fact that it is a strong vein in Sullivan County, with the evidence of its presence as a second or lower vein near Lockport, Riley Township, leads us to expect that it, as a good, strong vein, underlies the whole southern portion of our county.

Yet this is by no means certain. Near Middletown, on the N. W. ¼, Sec. 35–10–10, Mr. S. E. K. Fisk drilled a well to a depth of 441 feet. Commencing in a little valley, he reached coal "M" at a depth of 13 feet, then through 65 feet of shale or soapstone to one foot of coal, probably coal "L;" then through shale, sandstone and a little limestone

*See pages 98, 106 of this volume.

about 100 feet to coal three feet and six inches thick, which is, perhaps, coal "K." Below this he found two or three thin veins of coal, and artesian water and gas at a depth of 430 feet.

The strata of Vigo County rise toward the east. Coal "L" outcrops at Coal Bluff, and in Clay County, about three miles east of Seeleyville. Near the county line, in the bank of Otter Creek, on the east side of the N. E. ¼ of Sec. 8–13–7, two veins of coal are found. They are below coal "L," and the section is about as follows:

	Ft.	In.
Coal "L" as on Sec. 12–13–8	7	00
Fire clay and shale	25	00
Shale, black, slaty, sandy	2	00
Coal	2	06
Fire clay and shale	5	00
Shale, black, slaty	1	00
Coal	3	00
Fire clay and shale	10 + or —	

Mr. Talley says these two veins are about 25 feet apart at Perth, about three miles east in Clay County, and they are about the same distance apart at Fontanet. Some coal has been taken from these veins at the outcrop, but in our county they are too thin for successful mining as far as they have been explored.

A generalized section of four holes drilled near Caseyville, Clay County, show other veins of coal that may be looked for in Vigo County:

	Ft.	In.	Ft.	In.
Surface soil and clay	00	00	10	00
Hardpan—boulder clay	00	00	30	00
Shale and slate	00	00	10	00
Coal	2	6 to	4	5
Fire clay and shale	00	00	30	00
Coal	3	3 to	5	3
Fire clay and shale	00	00	30	00
Coal	00	00	3	7

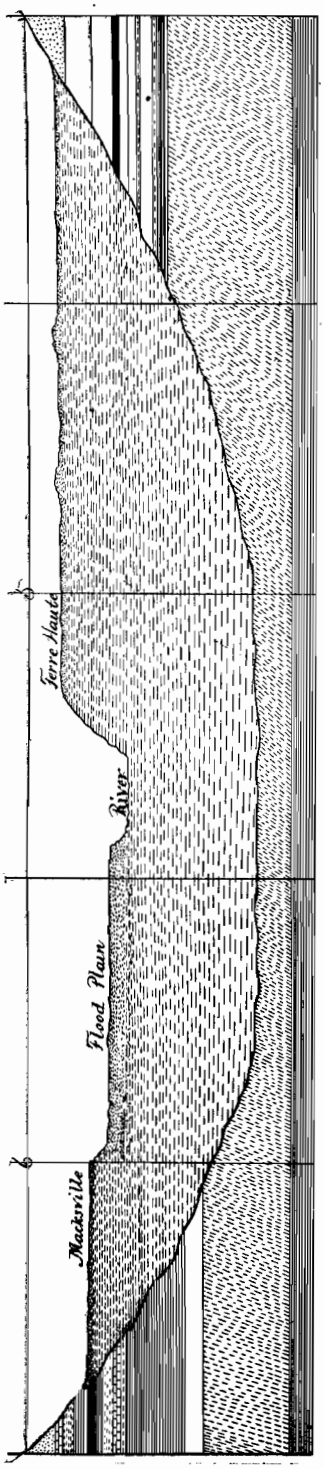
These are block or semi-block coals, and are mined extensively in the southeastern part of Parke County and the northwestern part of Clay County. Before reaching Vigo County these veins have become bituminous coals and are so thin bedded that it is not considered profitable to work them.

The numerous holes drilled for water, oil and gas have shown no other veins of coal or other rock strata that are liable to become valuable to the miner or quarryman.

TOPOGRAPHY.

Vigo County is a portion of a double slope. Its rocky strata inclinse westward toward the Mississippi and southward toward the Ohio, the westward slope being the more rapid. This circumstance seems to have had much to do in determining the topography of the county. The river flowing toward the south crosses the more rapid slope nearly at right angles. This dip of the strata westward probably causes the river to crowd its western bank, making it more abrupt than the eastern. The tributary streams flow easterly and westerly, with a trend toward the south, this trend being more pronounced in the western streams. The southerly dip of the rocks not only causes a southerly trend in the direction of the streams, but it causes them to crowd their southern banks, making them more abrupt than the northern. In general there are no streams flowing toward the north, the south branch of Honey Creek being the only stream of any size flowing in that direction. The greater portion of the surface of the county slopes toward the river, but portions of Riley and Pierson Townships are in the valley of Eel River. The divide between the two rivers is a massive body of land lying in Linton and the western part of Pierson Townships, and trending northeasterly through Riley Township. The northeast quarter of section 18, 670 feet, and section 20, 660 feet, of Pierson Township are the highest points in the county. Section 1 of Linton Township, and section 6 of Pierson, and portions of Riley have an elevation of from 640 to 650 feet, which is about the same as the higher portions of Fayette, Nevins and Lost Creek Townships. While the strata in general dip to the west, there are some local exceptions or irregularities. In section 1, Linton Township, there is a sharp dip to the east, and another in Riley Township, with some evidences of another in Pierson, but the evidence is not sufficient to determine whether the divide is an anticline, or not. This divide is a rocky mass with just a thin veneering of boulder clay and soil, and must have divided these valleys in preglacial times.

The most marked feature in the topography of the county is the immediate valley of the river. It is from five to six miles wide and extends through the whole length of the county, but as the river forms the western boundary of the southern third of the county, only that portion of the valley on the east of the river belongs to Vigo County. This valley is an old channel that has been partly filled with sand and gravel. The numerous wells drilled in Terre Haute and vicinity shows the rock bed of this old channel to be from 120 to 150 feet below the general level of Terre Haute. The high land just east of the river, in the north part of the county, was part of an island in the ancient river. The channel east of the island is now occupied by Raccoon Creek of Parke County. This eastern channel



A Cross Section of the Wabash Valley at Terre Haute, Ind.

of the old river accounts for the sudden widening of the valley just south of the county line. In Prairie Creek Township there is another island. The narrow channel east of the island is now occupied by Prairie Creek. The valley of the river turns abruptly toward the west above the island and is somewhat narrow below. The main channel of the old stream was along the west bank. The rocky banks, the islands, the main channel, the secondary channels and shallow places are so well defined that we can almost see the old river, whose waters carved out such a broad, deep trough through our county. The river and its flood plain occupies the western one-third of the valley. The river washes the western bluff at Durkey's Ferry and its flood waters wash them at various places. The greater portion of the flood plain is from 14 to 18 feet above low water in the river, and scattered over them there are many ponds and sluggish streams, indicating a very uneven surface. Between the flood plain and the bluffs there are fragments of a low terrace, which is sometimes of gravel and sometimes of rock. The eastern two-thirds of the valley is occupied by a massive gravel terrace which has a somewhat irregular surface. Through Otter Creek Township it is much higher along the river, sometimes rising to 70 or 80 feet above low water, then sloping gently eastward. In Harrison Township it is not more than 50 feet above low water, and while there are low ridges and shallow valleys trending

toward the south there is no slope toward the east. Through Honey Creek and Prairieton Townships the terrace gradually diminishes in elevation until it finally fades into the flood plain of Prairie Creek Township. Large portions of this terrace are flat and not well drained, so that they were originally swamps, marshes, wet prairies and ponds. The island that projects into the northern part of the county may, perhaps, be called a portion of the river valley. Where crossed by the county line the elevation is about the same as that of the high lands west of the river, but it soon begins to descend toward the south and within two miles has merged imperceptibly into the terrace. The surface is somewhat broken along the upper portions of Clear Creek.

The terrace is continuous into the valley of Raccoon Creek, and the ancient Raccoon Creek doubtless flowed into Vigo County, but while small portions of Nevins Township are drained into this creek, it hardly seems necessary to describe its valley.

Otter Creek, rising by several branches, generally in Clay County, drains a large and interesting area of country, including the greater part of Nevins Township and the southern portion of Otter Creek Township. The two main branches unite near the western boundary of Nevins Town ship. The valleys of these streams are from one-eighth to one-fourth of a mile wide, the stream usually nearer the southern bluff, which is generally more abrupt and more frequently rocky. The southern tier of sections in Nevins Township is drained by a third branch, which enters the main stream in the southeast part of Otter Creek Township. The branches of these streams are not large, nor numerous, but the land along the streams is badly broken up. On the divide between the north branch and Raccoon Creek valley there are several sections of good farm land, and some between the two branches, but fully one half of the township is too much broken for first-class farm-land.

The extreme southeastern portion of Otter Creek Township is very broken; the heavy bluffs south of the creek extending westward into section 31. North of the creek there are some hills, but no regular bluff. There is also some broken land in sections 5, 6 and 7, but in general the surface of this township is well adapted to agricultural purposes.

Lost Creek is a small stream that drains the central portion of Lost Creek Township, flowing through Harrison Township into the river. The valley is shallow, and the banks are seldom abrupt. Some of the smaller branches of the Otter creeks are evidently young streams, but the main creeks seem to flow in old channels. The valley of Lost Creek seems to be of recent origin. The extreme northeastern portion of Lost Creek Township is drained by a branch of Otter Creek, and a few sections in the southeast are drained by branches of Honey Creek, while a portion of the southwest is drained by Church's Run. Sections 1, 2, 11, 12, 34 and 35 contain about all the broken land of this township. Some sec-

tions, as 22, 23, 27 and 28 are nearly level, seeming to have about the same surface that was left by the glacier, as the drainage channels have not penetrated them to any extent. Harrison Township lies almost wholly in the valley of the river and generally has a good surface. Honey Creek, rising in Clay County, flows southwesterly through the southeastern sections of Lost Creek Township, through the northwestern portion of Riley Township, westward through Honey Creek Township, and southwesterly through Prairieton into the river. It is about the size of Otter Creek, but has a much longer course in the county than any other creek. It drains the southeast of Lost Creek, the north and west of Riley, the northwest portion of Pierson and the northeast of Linton townships and the whole of Honey Creek and Prairieton townships. In its southwesterly course to section 10 in Riley township the valley is somewhat symmetrical, but in its westward course the south bank is much more abrupt and extensive as it continues into section 21 of Honey Creek Township, while the north bluff stops in section 13 and is not strong there. It has several branches from the east and southeast, but the largest is the south branch, which drains parts of Pierson and Linton townships, being the north side of the highest elevation in the county. The valleys of this branch and its tributaries are deep, but somewhat irregular, perhaps more bluffy on the west, but not much difference. The southeast portion of Riley Township lies in the valley of Eel River, and is drained by Splunge Creek. The surface of this township along Honey Creek is much broken, but the greater portion of the township has a good surface.

A few sections of Honey Creek Township lying south of the main stream and along the south branch are broken, but by far the greater portion of the township has a good surface. The southeastern portion, about one-third, is upland; the balance is in the river valley. Some of the valley land is low and flat and has been drained with considerable difficulty.

Prairieton is wholly in the main valley. Along the river there is considerable flood-plain, and several bayous, but in general the surface is good, although some parts are marshy or swampy.

Prairie Creek rises by three branches in the north half of Linton Township. These branches unite in Sec. 8 of Linton Township, forming Prairie Creek. The creek flows westerly, and in the W. ½ of Sec. 7 enters the east branch of the old valley, and in Sec. 12 of Prairie Creek Township turns southwesterly to the S. W., N. W. Sec. 26, thence westerly to the center of Sec. 30; thence southerly into the river in Sec. 13-9-11 in Sullivan County. A branch rising in Sec. 21, Linton Township, flows into the main stream in Sec. 24 of Prairie Creek, and it receives quite a large branch from the north in Sec. 27. The branches seem to occupy recent valleys. They are comparatively shallow, and the bed of

the stream is often rocky or of boulder clay. The branch of the old channel occupied by the main stream is about three-quarters of a mile wide, with some high bluffs and some low, sandy hills. Prairie Creek and its branches drain the greater part of Prairie Creek Township. Parts of Secs. 9 and 10 drain into Greenfield Bayou, and parts of Secs. 35 and 36 are drained southward by branches of Thurman's Creek. Nearly one-half of the township lies in the main valley and is mainly flood-plain. The valley of Prairie Creek, or the old channel east of the island, occupies about four sections, so that more than one-half of the township is bottom land. There is some broken land along the bluff lines, but it would not amount to more than three or four sections. The northern part of Linton Township is drained by the branches of Prairie Creek, while the southern part is drained southward by the branches of Thurman's Creek. Section 1 and parts of 2 and 12 are drained by the south branch of Honey Creek, while section 36 and parts of 25 and 35 are drained toward the south by a branch of Busseron's Creek. Portions of sections 6, 7 and 18 are in the old channel, but the greater part of the township is high land. The valleys of the streams are comparatively narrow and shallow, and there is very little broken land.

The northwestern portion of *Pierson's Township* is drained into Honey Creek, the eastern portion into Eel River through Splunge Creek and branches, and the southern portion is drained by the branches of Busseron's Creek. Sections 32 and 33 and parts of Secs. 6, 28, 34 and 35 are considerably broken. The balance of the township has a good surface and is well adapted for agricultural purposes.

Fayette Township is mainly drained by Coal Creek. A few little streams flow into Brouilett's Creek and the river, and a few sections are drained by East Little Sugar Creek. Coal Creek rises in Illinois and the west part of the township and flows southeasterly into the river. Its channel is deep, narrow and rocky, and its bluffs are abrupt. It seems to be a new or recent valley. The same is true of its branches and of two or three small streams that flow directly into the river.

Four or five sections in the northeast of Fayette are in the main valley, but the balance is upland. There are several sections of broken land along Coal Creek and the river bluffs, but the greater part has a good surface. This surface in the west is diversified with gently rounded hills of various sizes that rise from 20 to 40 feet above the surrounding level. Frank Leveret, of the United States Geological Survey, says they are parts of the Shelbyville or Wisconsin Moraine. Both north and south of Coal Creek the surface inclines gently from the State line to the bluff near the river, forming one of the finest slopes in the county.

Sugar Creek is the largest of the townships, and topographically is perhaps the most interesting. Big Sugar Creek runs from west to east across the center of the township. It is a strong stream, having a course

of 20 or 25 miles in Illinois before entering the county. In Vigo County the valley is from 70 to 100 feet deep, and from one-half to three-quarters of a mile wide. The creek in general is near the south bank, which is much more abrupt than the one on the north. In Section 23–12–10 the creek cuts through the limestones above coal "N." At this point the rock channel is not more than 30 rods wide, while the valley proper is as wide as ever. In N. E. ¼, Sec. 25, where it joins the main valley, the rocky walls of this valley are not more than 40 rods apart. Above Section 23 the walls of the channel in this county are mainly of boulder clay. Sugar Creek receives only two or three small streams from the south, but has two large branches from the north. West Little Sugar Creek, which, rising in Illinois, enters at the northwest corner of the township, and, flowing a little east of south, joins the main stream in the east part of Section 22–12–10. And East Little Sugar Creek, which rises in Fayette Township near Coal Creek, and, flowing southerly, enters the big creek in the west half of Section 30–12–9. A branch of this creek rises in Section 34, Fayette Township, and, flowing a little east of south, enters the east branch in Sec. 24–12–10, so that the northern portion of the township is drained by three nearly parallel streams, each of which has a deep, narrow valley. Each of these streams shows some rocks in its banks or bed, but in general their channels are in boulder clay. The narrow channels of the main stream and of the east branch in their lower course suggests the idea that these streams may flow in recent or post glacial channels in the lower part of the course. The rocky strata dips toward the west but the surface inclines toward the east, and the thick beds of boulder clay toward the west may have changed the drainage area somewhat, so that a much larger territory is tributary to the present Wabash than to the ancient stream. Clear Creek, rising in Illinois, enters the county in the south part of Sec. 28–12–10, and flowing southeasterly joins the river in Sec. 11–11–10. Its valley is as deep as that of Sugar Creek but not as wide. Its channel is also rocky and narrow in its lower course. The extreme southern portion of the township is drained by two streams that rise in Secs. 3 and 4–11–10, and running in nearly parallel courses, flow into Hawk Creek which, flowing through Sec. 16, reaches the river near the center of Sec. 22–11–10. The surface of the township is very much broken, more so than that of any other township. The long river bluff, and the bluffs of two streams that cross the township, and the bluffs along the three streams that drain the northern portion, occupy fully 75 per cent. of the area of the township. The rocks associated with coal "N" crop out along the river bluffs and to some extent in other places, but in general the bluffs are of boulder clay, and one comes to think of the township as a mass of boulder clay and other glacial debris, through which the surplus waters are digging channels, as

day by day they work at their task of carrying these materials down to the gulf. This task is only well begun. Wide areas on the divides are practically level, with no established drainage lines, showing little evidence of change since the retreat of the ice. The tributary streams, with their deep, narrow, V-shaped channels are reaching up into these areas and rapidly curtailing their extent. One can find numerous instances of from 6 to 10 of these little streams heading up into one 20-acre tract. Similar features occur to some extent in Fayette Township, and east of the river also, but in no place are they as well marked as in Sugar Creek Township. These peculiar forms of relief give the region a new and unfinished appearance. The broken nature of the surface is well indicated by the direction of the roads of the township.

The topography of Vigo County presents no very striking characteristics, but shows many very interesting features. The post glacial drainage system is young and has not yet been able to reveal the ancient topography in detail. East of the river the drainage in general follows the dip of the strata and the old drainage lines, so that the recent topography is probably quite like the old. On the west of the river, however, there is evidence of different lines of drainage, and other evidence which indicates a wide divergence between recent and ancient topographies.

ANCIENT CHANNELS.

The only records we have of this region during the nine or ten millions of years that intervened between the Carbonic and Quaternary eras are the old, half-buried channels that occupy so much of the area of our county. The main channel is somewhat irregular in width, but will average fully six miles from bluff to bluff. Like modern streams this old river had islands. Between Atherton on the west and Rosedale on the east a ridge of land rises some 200 feet above the river. It is the southern prolongation of a great island that divided the ancient stream, about three-fourths flowing on the west and one-fourth on the east. The island is about 13 miles long and from two to four miles wide. Raccoon Creek now flows northward through the eastern channel of the old river. The island extends about two miles into Vigo County, descending rapidly but not abruptly from the county line toward the south. On the county line the western channel is about three miles wide, three miles north it is only two and a half miles wide, but soon spreads out to a width of three or three and a half miles. The east channel will average about one-half mile in width. From the southern point of the island, near the center of Sec. 7, to the eastern bluff in Sec. 16, Otter Creek Township, the distance is about two miles, which represents the channel of Big Raccoon Creek, Little Raccoon Creek and the east channel of the river. These combined with

the main channel of the river and that of Brouilett's Creek make a valley six miles in width. In Honey Creek Township, where Honey Creek enters the main valley, the eastern bluff turns abruptly toward the west for about two miles to the center of Sec. 21–11–9, then southwesterly. In Prairie Creek Township there is another old island, known as Johnson's Hill. It is somewhat quadrangular in form, being about three miles in extent from north to south and from east to west. In sections 10, 9 and 16–10–10 on the northwest and in sections 13, 24 and 26–10–10 on the southeast, the bluff is abrupt, rising from 75 to 100 feet above the flood plain, while in sections 11, 12 and 21 the slope is very gradual down to the bottom lands. The eastern portion of the channel is now occupied by Prairie Creek, which in the west half of section 26 turns toward the west into the main channel in the east half of Sec. 29–10–10. On the south line of the county from the center of Sec. 32–10–10 to the western bluff in Illinois the distance is about five miles. The western bluff is more abrupt, more uniform in elevation and direction than the eastern, which in many places is low, the bed rock rising very gradually to the surface. The valleys of Otter Creek and its branches and of Honey Creek and its branches seem in general to be old, partly buried channels. But in the case of Lost Creek and Prairie Creek in its upper course the evidence is not conclusive.

I am inclined to think, however, that a portion, at least, of Prairie Creek valley is in an old channel. The old channel of Brouilett's Creek does not include much of Vigo County. Coal Creek valley seems to be recent—the work of the present stream. Sugar Creek and its branches are undoubtedly flowing in old channels, and so are Clear Creek, Hawk Creek and Big Creek from the west. It is sometimes suggested that the old channel of the Wabash was possibly the outlet of either Lake Michigan or Lake Erie, and that it is the result of a much larger drainage area than that of the present river. This question can scarcely be settled from a study of local details, but the size of the tributary valleys, which are supposed to be local, seems sufficient to warrant the idea that in general the ancient Wabash had a drainage area of about the same size as that of the present stream. During the glacial period water from Lake Erie flowed through the Wabash to the sea, and perhaps at other times also; but usually it probably had a more restricted drainage basin. The main channel seems to have been fully re-opened after the glacier, but there is evidence that many of the tributary valleys are still filled with boulder clay, gravel and sand, showing that the local drainage must have been much more extensive than would appear from a surface examination. In many cases along Otter Creek, Sugar Creek and other streams there are great bluffs of boulder clay upon which these streams are working in their attempts to clean out and occupy their ancient channels. The

flow of water from Lake Erie, and perhaps other sources, enabled the river to clear out its old channel more rapidly than the local streams with only an ordinary supply of water.

In coal mines abundant evidence is found of much more extensive erosion than appears upon the surface. The Union mine, at Fontanet, is about 110 feet deep, through hard pan 55 feet, and rock 55 feet. But within 150 yards of the shaft the rock has been cut away and the boulder clay rests on the coal; while a few yards farther, in the same direction, the coal has disappeared, the rock and coal both being cut out by erosion and afterward replaced by sand, gravel and boulder clay. It is a common thing for the miner along Otter Creek or Raccoon Creek and in other localities to find the coal that is less than 125 feet below the plateau surface cut out by sand bars, gravel beds or boulder clay. So common and extensive are these old channels, that Mr. Talley, of the Coal Bluff Mining Company, tells me they never buy 40 acres of coal land without drilling at least four prospect holes in order to make sure they are buying coal and not simply boulder clay. Near Fontanet one drill hole penetrated boulder clay 120 feet. At St. Mary's it is 100 feet to bed rock and at Sandford it is about 150 feet. A little beyond it is 180 feet to shale, while the rock comes near the surface within a short distance of each of these localities. The south part of the county would probably yield similar testimony if it were tested with a drill. These facts indicate extensive local erosion prior to the Glacial period, and I think indicate that the proportion between the main river and its local tributaries was formerly much the same as at present. These channels vary in depth. The river wells reach bed rock about 80 feet below low water in the river or about 365 feet above tide, while the plateau in many places is over 600 feet above tide. Wells in other parts of Terre Haute reached shale at about the same distance below the river, so that we are sure that a considerable portion of the main valley was formerly 225 feet or more below the general surface of the uplands. The tributary channels are probably much shallower than the main valley, but little is known of them beside an occasional well. Drift materials are known to be of considerable thickness in the valleys of Sugar Creek and of Otter Creek. The beds of the present streams are from 60 to 80 feet below the general surface of the uplands, and the bed of the old channel is at least as much as 60 to 80 feet lower still. The walls of these old channels, where exposed, are often quite abrupt, so that the county in all the myriads of years had not been base-leveled. It is evident that a vast amount of material has been removed from Vigo County by erosion, but when we consider the length of time, the amount does not seem to be relatively great, and is seems probable that for much of the time this region was near the level of the sea, so that the action of eroding agents was weak and ineffectual.

THE GLACIER IN VIGO COUNTY.

In common with the northern parts of Ohio, Indiana and Illinois, Vigo County was once or twice covered with glacial ice. The causes of the glacial period are not known. It is generally believed that toward the close of the Tertiary era there was a very considerable elevation of the northern portion of the American continent. One result of this elevation was doubtless an increased rain-fall with much more vigorous erosion. It is probable that these extensive elevations were important factors in causing the severe climate that gave rise to the glaciers. The growth of an ice sheet or glacier, like most geological processes, is a matter of time. There were several gathering grounds, but the highlands of Labrador seem to have been the center from which the ice that covered the greater part of Indiana originated. On these highlands the snow and ice of the winter was not entirely melted by the heat of the following summer, and as this occurred year after year, and century after century, the ice gradually spread out over Canada, New York, Michigan and the greater part of Ohio, Indiana, Illinois and other States. During the centuries preceding the ice invasion, rain, heat and cold, vegetation, animal life, the chemical action of air and water had softened and broken up great quantities of surface rocks into materials from which soils, clays, sands, gravel and boulders were formed. As the ice advanced it gathered up these materials, broke up the more prominent rocky masses, ground down the hills, smoothed out the valleys and eroded the general surface more or less deeply.

The ice not only swept away the soils, but drove out or destroyed all forms of life and deluged the adjacent regions with summer floods. The regions passed over by the ice were smoothed and polished, and all the prominent features of the surface were softened down, and the whole aspect of the county changed. At length, for some unexplained reason, the ice ceased to advance and soon began to retreat. Its retreat was as gradual as its advance had been, each accompanied with halts and re-advances, but finally it was melted away and the glacier was no more. As the ice melted, the load of rocky fragments which it had brought from the Laurentian highlands, with additions gathered on the way, were left as a thick mantle of till or boulder clay spread out over all the region occupied by the ice.

This material filled up the old drainage channels, so that the surface was a plain of gently undulating surface.

But the floods from the retreating ice soon began to form drainage channels, sometimes reopening old channels, sometimes forming new ones, sometimes following old channels in general, but occasionally cutting off some bend, giving rise to many curious features in the streams of glaciated

area. The retreating ice for a long time made a dam across the Maumee Valley, so that a lake was formed. The surplus waters of this Maumee lake were discharged across the divide near Fort Wayne into the Wabash Valley and through it to the gulf. This extra supply of water seems to have cleared the old valley of boulder clay, at least in this region. The thickness of the boulder clay in Vigo County is from nothing up to 150 feet. The thicker beds are probably in old channels. Frank Leverett, who has given the matter much attention, says that the average thickness for this portion of Indiana is about twenty-five feet. While the new drainage channels were being opened the surface of the boulder clay weathered into soil, and became covered with vegetation. The remains of this vegetation, partially decayed, mingled with the clay, forming a black soil. Similar soils are formed at the present time on poorly drained tracts in the northern latitudes. This old soil occurs in the eastern and southern parts of the county, under several feet of material deposited at a later period.*

Above this old soil there is a deposit of loess. "Loess is a fine-grained yellowish silt or loam, which overspreads the southern portion of the glacial drift in North America. It consists principally of quartz grains, but it usually contains a variety of such other minerals as occur in the drift. It is apparently derived from the drift, either by the action of water or of the wind. It often contains calcareous matter which partially cements it. Sometimes irregular nodules of lime and of iron and manganese oxide are found in this material. It also often contains fossil shells of land and fresh water mollusks, and occasionally remains of insects and bones of mammals. It has a strong tendency to vertical cleavage and usually presents nearly perpendicular banks on the borders of streams which erode it." It occurs at several places along the bluffs east of the river, and probably west of the river as well, but I have not noticed it there. There is a thick deposit in the bluff on the Bloomington road; in the bluff just south of Otter Creek and in the bluff at Atherton on the north line of the county. Over this loess there is, in southern Indiana, a continuous layer of pale silt called "white clay" which is the surface soil over much of the uplands of Vigo County.

Later a second ice sheet overspread the country reaching as far south as the northwestern part of our county, including Sandford. When the ice sheet halts for some time accumulations of gravels, sands and clays are formed by the materials dropped by the melting ice. Such accumulations are called moraines. Sometimes a continuous ridge of considerable extent occurs, but more generally the moraine consists of low rounded hills. The hills east and northeast of Sandford are parts of the Shelbyville or Wisconsin Moraine that marks the southern boundary or limit of a second ice sheet. The moraine extends northeasterly across the river into Parke

*See Inland Educator for August, 1896.

County, being well marked to the north of Atherton. In the northwestern part of Fayette Township the white clay has been covered by a deposit of darker material brought down and deposited by this later ice.

The surface rocks of Vigo County are generally shales or friable sandstones which do not retain the marks of glaciation for any great length of time, so that but few glaciated surfaces have been found in the county. On the east side of the S. W. quarter, section 3–10–9, Linton Township, in the bank of a branch of Prairie Creek I found a glaciated sandstone, under forty feet of soil and boulder clay, the striæ running south, 25° west. Between the boulder clay and the rock there was a thin layer of very fine clayey material. On the N. W. quarter of the S. E. quarter, section 26–10–9 in the bank of a branch of Thurman's Creek I found glacial striæ on limestone and a glaciated fragment of similar rock in the boulder clay some twenty feet above the bed rock. The direction of the striæ was a little east of south.

The surface of the rock in the Lochner Coal Company's shaft at Seeleyville was glaciated.

At several places in bluffs of boulder clay I have found old wood from twenty to forty-five feet below the surface. Sometimes this old wood was fragile, soon crumbling on exposure to the air, in other cases it was in good condition and is still firm after being exposed to the air for a year. Wood has been found in digging wells in different parts of the county, so that old wood is quite common in the boulder clay of Vigo county. The specimens found were of cone bearing trees, probably some kind of cedar. One specimen showed over thirty rings of growth in a quarter of an inch. One ring was composed of only two layers or rows of ducts. These narrow rings of growth seem to indicate that there had been more winter than summer in the life of that little tree or shrub.

THE RECENT VALLEYS.

The glacier accounts, in a general way, for the soils and drift materials of the uplands, but the soils and other materials in the valleys need explanation. The old channel of the river was swept of boulder clay, probably by water from outside its ordinary water shed. After a time the ice melted out of the Maumee Valley, and the waters of Maumee Lake found a new outlet. The Wabash, diminishing in power, began silting up its bed with sand and gravel. This process continued until, in Vigo County, there was deposited a bed of gravel 20 miles long and four to five miles wide, and over 100 feet thick. This bed is of unknown extent toward the north and south. The great masses of gravel at Lafayette, and at intervening points, are, perhaps, parts of the same great bed. How can it be accounted for? In the record of some of the deep wells, the upper portion of the drift materials is shown to be coarse, while

the lower is of smaller size. This, if a fact, suggests delta formation. One who studies the gravel pit will feel sure that the sands, gravels and boulders were arranged by water, but under what circumstances could the water get these rocky fragments of varying sizes together. A study of the upper portions, as seen in the gravel pits, suggests stream action, and possibly the whole mass was a delta formation whose upper portions were rearranged by stream action. Of something over 600 gravel stones examined, about 35 per cent. were limestones; the remainder were fragments of different kinds of granite rocks. The fragments vary in size from fine sand up to stones six inches in diameter, with occasional large boulders. The surface features, at least, seem the work of a strong stream. The ridge just west of Seventeenth street, which extends southward east of the old canal, seems to be an old sandbar. The ridge along Fifth street, which terminates in Strawberry Hill, is apparently another old sandbar. This mass of sand and gravel in the main stream must have dammed up some of the tributary streams, forming long, narrow lakes.

Later, the river seems to have become narrower and more rapid, possibly on account of elevation of the northern portions of the continent, so that the western one-third of the valley was cut down some 20 feet or more, leaving the eastern two-thirds as a gravel terrace. The margin of the terrace has a direct course a little west of south from three miles north of the county line in Sec. 13–14–9 to Sec. 5–11–9, Honey Creek Township, where it turns to the southwest.

Sometime after this the energy of the river seems to have been concentrated upon narrower limits and a channel was cut deeper into the gravel, leaving a narrow fringe of second terrace or second bottom along the western bluff, which is about 30 feet above low water in the present river, while the main terrace rises from 40 to 70 feet above the low water. Then the river ceased to erode the gravel, and even when in flood it can only work over the materials of its own floodplain. As one watches the river when in flood, with its deep, strong current and finds it unable to erode the gravel he can not help wondering as to what manner of a stream it was that cut out that great mass of gravel and carried it to unknown distances below. The river flows along or near the western bluffs, and its tributary streams flow along the southern bluffs. This is universal. There is hardly a rocky cliff or bank of boulder clay that does not face toward the north or toward the east. I can think of only two or three exceptions along the narrow parts of Coal Creek Valley. This is perhaps due to the fact that the strata generally dip toward the south and west. It is possible that the main current of the stream that deposited the gravel was on the west and that the gravel was not as deep on the west. If true, the later streams had less work to do than we have ascribed to them. The lands of Vigo County were surveyed in

1815 and 1816. The meander of the river made at that time was not carefully done and the records are incomplete, so that no very definite conclusions can be reached as to the amount of change made in the course of the river since that time. But it seems certain that in no instance since that date has the river been able to erode the gravel. Those portions of its channel, where at least a fringe of timber has been left along the river have not materially changed. But on the curves, where the timber has been cut away, the erosion has been extensive, so that the bed of the river has moved from 600 to 800 feet, as at the bends in S. E. Sec. 8, and S. W. Sec. 16–12–9, and in S. W. Sec. 32–12–9, Harrison Township.

The main terrace descends gradually towards the south from the north part of Honey Creek Township to the northern part of Prairie Creek Township, where it becomes the flood plain. Whether the terrace formerly extended farther south and has been cut down by erosion to its present extent and form, or whether it never extended any farther than at present, and has the original termination modified only by ordinary atmospheric influences, are questions which I can not solve. I am inclined to the opinion that the high terrace never extended much beyond its present position.

Just above Clinton, Vermillion County, about five miles north of our county line on the west side of the river, a section of the high terrace terminates quite abruptly. It rises about 60 feet above low water, while the second terrace on which Clinton stands rises from 35 to 40 feet above the same level. The river valley is narrow, only about two miles wide in this locality. The high terrace appears again about two miles below, but on the east side of the river and in full force just below the narrow place in the valley. The high terrace does not seem to have been formed in the narrow portion of the channel. Many streams flowing into the main valley are lost in the sands and gravels. In time some of them brought down clay enough from the hills to puddle large areas of sand making it impervious to water, and marshes, swamps and wet prairies were formed. Fort Harrison prairie, which extended through nearly the whole length of the county was largely wet prairie that had its origin in obstructed drainage. The Macksville terrace across from Terre Haute is a typical gravel terrace, but much of the second bottoms is really a rocky shelf. Near the I. & St. L. R. R., it is a shelf of shale above coal "N." South of Sugar Creek, for some distance, it is a shelf of limestone. Other interesting features of the old valley might have been mentioned, but enough has been said to show that the channel of the Ancient Wabash contains many interesting problems for the one who has time and opportunity for studying them.

The tributary valleys differ widely from the main valley. In them the drainage was purely local, and it, at times, was not relatively as strong

as in the main valley. The great floods from the retreating glacier soon ceased to influence the local streams, but continued for centuries to strengthen the river. Changes of level that would materially affect the character of the main stream might have little effect on the tributary. The boulder clay was all removed from the main channel in a comparatively short time, while the tributaries are still, after thousands of years, working on the boulder clay with which the glaciers long ago filled their channels.

In general, the tributaries seem to have cut downward as rapidly as the river, but could not open their channels to the full width as did the river. When the river silted up its channel with sands and gravel, they filled theirs mainly with sand, the local streams not being able to move as coarse material as the river. In some instances, at least, the main stream filled its channel so rapidly as to shut off the tributary stream, making it a pond or lake. In one of the branch valleys of Sugar Creek, on the N. W. ¼, S. E. ¼, Section 22–12–10, there is a deposit of very fine laminated clay, with occasional partings of fine sand, the whole resting in a trough of boulder clay. Where this deposit outcrops on the main creek it is from 12 to 15 feet in thickness, becoming thinner as it extends back from the creek. In some places it has the appearance of shale, but to the touch it is fine clay. I found some similar material about a quarter of a mile down the creek, which seems to indicate that the deposit was formerly more extensive, but had been carried away by erosion. I once saw an extensive deposit of similar material in Sullivan County, northeast of Merom.

The deposit is an interesting one, and indicates that this valley was occupied by quiet water for centuries, and that then the barriers were removed, the lake flowed away and the obstructed drainage system was reopened. The valley of Sugar Creek, in Secs. 16, 22 and 23, is wider than below, and the same thing seems to be true of East Little Sugar Creek, in Secs. 12 and 13. None of the other valleys have a similar form. The flood plain of the tributary streams is of different material from that of the main stream. It is more local in its character—sometimes clayey and impervious, again sandy or loamy. In many cases the smaller streams carry away valuable materials from their flood plains, while in general the river leaves its flood plain covered with a coating of rich, fertilizing sediments.

THE SOILS OF VIGO COUNTY.

Soils, for the most part, are fragments of rocks, and contain in varying proportions the same chemical elements which enter into the composition of the different rocks. The destiny of the rock masses which make up the continents, is the bed of the sea. The rocks softened by

water, expanding by day, contracting by night, fractured by the frosts of winter, by the roots of growing vegetation and other agencies, are finally broken down and carried away toward the sea by running water, by ice or by the wind. As these fragments move along, now rapidly, now slowly, sometimes resting by the way, they are gradually abraded and worn down as they jostle each other, till they become rounded boulders, gravel stones, sand grains and clay. Portions of these sands and clays, during some of their resting stages form the soils that cover the rocks and support the varied forms of vegetation.

Our soils are mainly of glacial origin. The boulder clay which forms so much of the uplands of the county is made up of clays and sands and gravels and boulders of various kinds. The great majority of the larger fragments are of granitic rocks from the Laurentian highlands, but there are numerous fragments of limestone, and some of sandstone and coal. The sandstone, the coal and some of the limestone, seem to be of a local origin. The gravels, sands and clays of the tributary valleys are doubtless of local origin, derived from the boulder clay which forms so large a part of their channel walls. The soils and subsoils of the main valley are mainly from foreign sources, although of glacial origin. The river at Durkey's Ferry and in N. W. quarter Sec. 14–11–10, Sugar Creek Township, is eroding shales. Coal Creek, Sugar Creek, Otter Creek, Honey Creek, and others, are eroding native rocks in many places, so that native rocks contribute considerable material to the soils of Vigo County, but the per cent. is very small when compared with that furnished by the products of Glacial action.

During the later erosion of the valleys, the boulder clay of the uplands or divides under atmospheric influences, became weathered or oxidized into yellow clay, which for the most part is the subsoil of the uplands. Upon this early soil there seems to have been a vigorous growth of vegetation, the remains of which added to the clay formed a rich dark soil, remains of which occur at several points in our county as on the N. W. quarter Sec. 32–11–9, Honey Creek Township, on the S. E. quarter Sec. 25–12–8 and on the S. W. quarter Sec. 24–12–8 Lost Creek Township.

After this erosion, and these soil changes had gone on for centuries, the whole area seems to have been covered with a fine, white clay, which is close and compact, but not sticky like the yellow clay. This difference between the two clays is very manifest in the roads that have not been graveled. On the level areas, where the white clay has not been cut away, the road may be firm and solid, but as it descends a little slope and comes into the yellow clay it may become almost impassable on account of the deep, sticky, mud. This white clay is the surface soil over most of the uplands of Vigo County. It belongs to the "White Clays" of southern Ohio and Indiana, which are described by Frank Leveret, of

the United States Geological Survey, as of glacial origin.* "A detailed study of the upper Mississippi region, by Professors T. C. Chamberlain and R. D. Salisbury led them to the conclusion that the distribution of the loess and associated silts and clays is best explained on a hypothesis of fluvio-lacustrine deposition. Evidence was found that the altitude of the region was much below the present, perhaps not far above the sea level, but instead of its being occupied by an inland sea, it is their conception that the valleys became silted up so that at the maximum of depression they were occupied by shallow, perhaps marshy, lake-like rivers many miles in width, whose waters moved slowly seaward from the edges of the ice-sheet. The constitution of these silts shows a direct derivation from glacial waters." The thickness of these clays is four or five feet along the border of the moraines, gradually thinning out toward the south, the thickness 20 to 30 miles from the moraine being little more than half as great. The thickness in Vigo County is from 8 to 24 inches. The largest continuous area of this white clay occurs in Lost Creek Township. From a bank at the roadside on S. W., S. W., Sec. 27–12–8, I took samples of the surface white clay and of the subsoil yellow clay. The white clay was from a depth of 10 inches, and the yellow clay from a depth of about 22 inches. These samples were analyzed by Prof. W. A. Noyes. The composition of the clays dried at 135°C is as follows:

	Yellow Clay.	White Clay.	Yellow Clay.	White Clay.
Silica (SiO_2)	72.87	79.77	54.40	79.94
Alumnia (Al_2O_3)	11.25	9.95	3.44	6.45
Ferric oxide (Fe_2O_3)	6.73	3.39		
Potassium oxide (K_2O)	2.26	2.05		
Magnesium oxide (MgO)	1.06	0.26	†2.42	†1.53
Calcium Oxide (CaO)	0.69	0.67		
Sodic Oxide (Na_2O)	0.39	1.08		
Titanium oxide (TiO_2)	0.95	0.70	.....	.....
Water (H_2O)	4.24	2.55	.....	.....
Total	100.44	100.42	60.36	82.92

RATIONAL ANALYSIS.

	Yellow Clay.	White Clay.
Quartz	42.43	52.30
Feldspathic Detritus	17.93	30.62
Clay substance	39.64	17.08
Total	100.00	100.00

†Insoluble in acids and sodium carbonate.

On the slopes in many cases the white clay has been washed away, exposing the yellow sub-soil, so that a field looks spotted. But in such

*See the American Geologist for July, 1892.

fields it is difficult to detect any difference in the appearance or yield of the crop growing on the two soils. Yet their difference, as shown by the analysis, is very well marked. In the northwestern part of the county, which is supposed to have been covered by the ice a second time, the white clay is covered up or mingled with other material, so that quite a different soil is the result. This mixed soil is called by some a better soil than the white clay. In the southeastern portion of the county, the Splunge Creek valley has a good soil which is neither a white or yellow clay, but seems to be a clayey mass like the sediment at the bottom of a pond or lake. It is free from gravel and boulders, and is not as sticky as the yellow clay. There are, perhaps, 12 or 15 square miles of this soil, most of which in the early times was covered with a rich mantle of prairie grasses. Sections 33 and 34, Prairie Creek Township, include some "quicksand land." The soil is a whitish clay for perhaps 8 to 15 inches, which is close and compact. Underneath this is the fine sand and clay which forms the quicksand. The upper soil will generally bear a team with an ordinary load when in motion, but if allowed to stop the load is liable to break through into the quicksand. In plowing, the horse on the unbroken soil has no difficulty, but the one that walks the furrow is frequently in the mire. The soil is fairly good, but is not considered as good as adjacent land in which there is less of the fine sand.

Along the bluffs on the east side of the river there are deposits of loess which at some places form the surface soil, but not over any large areas. Between Otter Creek and the valley of Raccoon Creek there are large numbers of sand dune hills, and several sections of land have a light, sandy soil which seems to have been blown from an ancient beach by the prevailing westerly winds. In some cases the sand lies on the bed rock, but generally it overlies boulder clay. Similar areas, but of less extent, occur north of Honey Creek, as on Secs. 12 and 13 of Honey Creek Township; also along Prairie Creek, as on Secs. 21 and 25, in Prairie Creek Township. In the northwestern portion of Fayette Township there are many areas of black lands that are much like the prairie lands of Illinois, and possibly they may be outlying masses of the prairies. The Morainic Hills, east and north of Sandford, are sometimes sandy, and sometimes wash easily, so that they can not be profitably cultivated. Along the bluffs of the river and its principal tributaries there are many steep slopes over which the drainage is so rapid that the soluble portions of the soil are washed away, leaving an impoverished residue that produces but a scanty vegetation. Such areas are numerous in Nevins Township along Otter Creek, and they occur along Coal Creek and Sugar Creek.

The main valley of the Wabash is divided into flood plains and terraces. The flood plain has a deep soil of alluvial sands and clays, vary-

ing widely in character from pure sand to rich clay. But the sands, mingling with the finer silts, soon become fertile lands. The clays are open and porous, so that the water penetrates them freely. These soils are generally rich and easily tilled. On the bottoms there are many shallow ponds, or sloughs, over whose beds oftentimes a deep black soil accumulates. The terraces usually have a sandy soil. But large areas, being nearly level, become covered with silt, so as to be nearly impervious to water, forming marshes or wet prairies with deep, rich soils. There are many sections of such soil in Otter Creek, Harrison, Honey Creek and Prairieton Townships. The tributary valleys have a rich alluvial soil, but it is largely of local origin, and is not as fine, nor as open in texture, as the soils of the main valley. Of the soils mentioned the alluvial clays of the flood plains, the sands of the terraces, and the clays of the uplands constitute the great bulk of the soils of Vigo County; the others, while occupying considerable areas, make up but a small per cent. of the whole.

A specimen of the alluvial clay of the flood plain from a depth of about two feet was analyzed by Prof. W. A. Noyes with the following results:*

Silica	66.11	
Alumina	13.78	
Water (combined)	6.34	
Clay base and sand		86.23
Oxide of iron	5.35	
Lime	1.67	
Magnesia	1.78	
Potash	2.11	
Soda	1.51	
Fluxes		12.06
Total		98.29

The sample was of clay that is used by the Terre Haute Pressed Brick Company in the manufacture of a good grade of dry-pressed brick, and represents the purer clays of the flood plain. Nearer the river there is more sand, often so much that it can not be used for brick making. Sometimes the clay is seamed with sand, and again the sand and clay will be quite distinct, though near each other, but the fine sediments brought in, year by year, soon make them both, sand and clay alike, rich and productive soils. We have no analysis of the sandy soils of the terraces, but a simple acid test shows them to contain quantities of lime. The gravels, coarse and fine, which appear to have had much the same source as the soils, contain much lime, at least 35 per cent. of the stones are rounded fragments of lime rock. These soils are more easily worked

*See 20th Geological Report, p. 76.

than the upland clays, and are quite as productive, and will in general wear longer; that is, will produce more good crops in successive years than can be produced on the clays.

The dense forests of native trees and the prairies with their rank growth of vegetation, proclaimed the richness of the soil to the early settlers. And the great fields of corn and wheat, the market garden products, and other crops that have contributed so much toward the wealth of the county, testify to the value of the soil under cultivation.

ECONOMICAL GEOLOGY.

The soils of Vigo County are her most abundant source of revenue. They have been, are, and probably always will be, the basis of her material prosperity. The glacier scoured the country for 600 miles in gathering up the materials for our soils. These somewhat heterogenous materials, rearranged in various ways by wind and water, and enriched by centuries of vegetable mould, constitute the widely varying soils of Vigo County.

The dense forests of valuable timber, the river prairies with their rank growth of forage grasses and the rich, easily cultivated soils, were the chief attractions to the early settlers of this region.

The first export from Vigo County was perhaps a cargo of furs, but the first and most important one to the early settler was a cargo of corn. The corn was shipped in the spring on flat-boats, usually to New Orleans. These flat-boats were made, for the most part, of yellow poplar, sometimes called white wood or tulip tree. This timber grew abundantly in the north part of the county on both sides of the river, but perhaps the finest and largest were on the east. The building of flat-boats for the corn and pork trade made great inroads upon the stock of yellow poplar, so great that one frequently hears an old settler speak about how the flat-boat trade destroyed the yellow poplar. While doubtless this valuable timber was used in a wasteful way in those early days the supply was by no means exhausted, and many farmers of Vigo County, after these many years, still get some income from the sale of yellow poplar. The black walnut was perhaps the most valuable timber tree of the county. It grew abundantly on the bottom lands as well as on the uplands, but those growing on the bottoms were larger and had a larger proportion of dark or heart wood. The supply is mostly gone, but in its day it was one of the important sources of revenue to the county. There are several different kinds of oak in the forests of the county, but perhaps the most valuable is the white oak. It grows on the uplands and often in the creek bottoms, and is more abundant in the northern portions of the county, Fayette Township being conspicuous for the size and quality of its white oaks. White ash, hickory, beech, maple, cottonwood, elm and

sycamore all grow well in Vigo County, and are marketable trees. There are many acres of land in Vigo that, on account of their broken and rugged character, could hardly be made good plow land that are well adapted to the growth of these valuable native trees. The black walnut, the yellow poplar, the linden or basswood, the white ash, the cottonwood, hickory and sycamore are all rapid growers, and would grow well on what is at the present time practically waste land. A growing crop of valuable timber trees is better than waste lands.

The crop of Vigo County is corn, and it grows best on the flood plains of the river and its principal tributaries. The wheat and hay crops are, perhaps, next in importance, while market-garden products from the lighter sandy soils are taking a leading place. The grasses of Vigo County have made her pasture lands famous among stock raisers, and it is claimed that the famous blue grass of Kentucky was imported from Indiana.

Coal.—The second most important natural product is coal. The county is rich in coal of a good quality. Two veins have been mined on the west side of the river and three on the east. On the west of the river there seem to be four veins of coal. Coal "O" outcrops along Coal Creek and at other places in Fayette Township. It is from three feet to five feet in thickness, and is good coal. In the eastern part of the township it lies considerably above the river and has been badly cut up by erosion, but there is still a large body of coal in this vein that can be mined easily and cheaply as soon as markets are opened and shipping facilities established.

Coal "N" outcrops along Sugar Creek and at points along the bluffs, west and northwest of Macksville. It is known as Sugar Creek coal. From the south part of Sec. 19–12–9, for over three miles northeasterly, the coal is nearly horizontal, being about the level of high water in the river. To the north and south of this region the coal descends, and but little is known of its thickness and character. As far as explored, it is a good strong vein from four feet to six feet in thickness, with a good shale roof. It has been cut out to some extent by erosion, but there is reason to think that "N" is a good workable vein, extending over the greater part of Sugar Creek and Fayette townships. Coal "M" does not outcrop in Vigo County west of the river, and has never been mined in that part of the county. But the artesian well at St. Marys shows "M" to be a five-foot vein, with a good roof, only 65 feet below coal "N." The well drilled for oil just west of Macksville showed this vein about 100 feet below the upper. It is a good vein at Clinton, and while coal "M" varies considerably on the east side of the river, we have reason to expect that "M" is a good workable vein over the greater portion of the county west of the river. Much that has been said of coal "M" can be said of coal "L," except that "L" is a thicker vein and, when explored, is generally more

uniform than "M." The St. Marys well shows "N" at 125 feet below the surface as five feet, "M" as a six-foot vein 190 feet below the surface, and "L" as a ten-foot vein 280 feet deep, so that three workable veins of good coal, aggregating 21 feet in thickness, occur west of the river. The strata dip toward the west, so that the coals are rather deep in the western part of the county; but the quantity of coal in these three veins underlying Vigo County is enormous.

On the east side of the river three veins have been worked for coal. The upper vein, "N," is not generally a strong vein. It varies considerably in thickness, but is usually good coal, and has a good roof of sandstone or shale. While much of it has been cut away by erosion, there are still thousands of acres of workable coal in this vein on the east of the river.

The middle vein "M" varies widely, from six feet near Lockport to two inches near Seeleyville.

I think the Alum Cave mines, with their 7 to 9 feet of coal, are on coal "M," but it thins out rapidly in all directions. Near Lockport it dips rapidly toward the west and increases rapidly in thickness. Does this change continue or does it soon thin out? We hardly know what to expect of coal "M" east of the river, but it must surely contain a great body of coal. The workable coal in these veins is mostly south of the National Road.

The big vein east of the river is coal "L." North of the National Road it lies near the surface, and has been channeled by erosion so that fully one-half of its area is gone, and in many places where the coal is left the roof has been destroyed so that mining is difficult or impossible. It varies from 6 to 10 feet in thickness, and while the slate bands are to be substracted from this mass, there is still left a "big vein" of coal. It outcrops in many places in Nevins Township and has been mined extensively there. It is a strong vein from Seeleyville northward to Rosedale, Coxville, Lyford and Clinton. It has not been explored very fully south of the National Road, but several drill holes indicate that it is a strong vein in the southern part of the county as well as in the northern.

Below coal "L" come the block coal veins of Clay County, but they have diminished somewhat in thickness and in general have ceased to be block coal, so that it is not considered profitable to mine from them. Southeast of Seeleyville drillings show some block coal, but it has not been fully explored.

The data are not at hand for estimating with any degree of accuracy the quantity of good available coal in Vigo County. But with "N" four feet, "M" four feet, and "L" six feet, with "O" above and the block coal veins below the coal supply of the county seems well nigh inexhaustible.

Shale and Clay.—In the Twentieth Report on the Geology of Indiana the origin, composition, classification and uses of shales and clays were discussed somewhat in detail, so that it will not be necessary to consider those phases of the subject at this time.

The stratigraphical column of Vigo County is headed by a thick stratum of shale that outcrops in great cliffs along West Little Sugar Creek in sections 4, 9, 10 and 15 (township 12 north, range 10 west) and along Coal Creek in sections 14, 15 and 23 (township 13 north, range 10 west) in Fayette Township. In these localities this shale is fully 50 feet in thickness. The great body of this bed is a fine aluminous shale of a dark-blue color. On Sugar Creek, toward the surface, there is some admixture of silica, and on Coal Creek there are sandstones and sandy shales of considerable quantity, but by much the greater portion of the stratum is fine shale.

No analysis was made of this shale, and I have never seen brick made from it, but there is no doubt but that it will make building brick, paving brick, sewer pipe or tiling of the very best quality. Below this bed and above Coal "O" there is a bed of shale from 30 to 50 feet in thickness. Sometimes this shale is interstratified with limestone, so that the thickness of good shale is much reduced, but generally the limestone forms one compact stratum with a bed of very fine aluminous shale below it, as on Coal Creek, near the gravel road, on section 20, township 13 north, range 9 west, and similar outcrops occur on sections 6, 9 and 17, same town and range. This shale is of a lighter color than the upper, and seems to be freer from silica. Between Coals "O" and "N" there are three shales, one above the limestones, one between them, and one below. The upper shale on the southwest quarter of section 19–12–9, and on section 25, township 12 north, range 10 west, is above the limestones, while Thorpe's shale on southeast section 23–12–10 is between the limestones, and the shale of the Terre Haute Brick and Pipe Company on section 18–12–9 is below the limestones. Specimens of the upper shale from William Larimer's place on section 25 were made into bricks with a Boyd dry press machine, and some were burned for building brick, and some for pavers. They are excellent brick. The building brick are of a rich dark-brown color, uniform throughout, have a clear metallic ring, did not shrink much in burning, and did not warp, and they are tough, not chipping easily. Architect Floyd, of Terre Haute, said of them, "that no finer brick were ever laid in Terre Haute, and that they were worth $30.00 per thousand, as well as one dollar was worth another."

The paving bricks shrunk considerably in burning, but did not warp. They are hard and tough, and absorb but little moisture. One of these brick, tested for strength by Prof. Malverd A. Howe, at the Rose Polytechnic shops, gave the following results:

"A brick from Vigo County shale. Cross breaking test. Area of cross section 8.49 inches, supported on knife edges six inches apart; the force applied by knife edge midway between the supports, using the Riehle testing machine. The brick broke under a pressure of 6,040 pounds, showing a strength per square inch of 2,900 pounds. In the compression test the brick was on cast-iron supports, with pine bedding. Area, 6.27 inches. The specimen cracked at 88,000 pounds and failed at 95,500 pounds, showing a strength per square inch of 15,230 pounds. A brick made from the bottom land clay used by the Terre Haute Pressed Brick Company, when subjected to the same tests, showed a cross-breaking strength of 1,300 pounds per square inch, and a compression strength of 11,940 pounds per square inch. Another, composed of one-third shale from Sec. 25, and two-thirds bottom land clay, showed a cross-breaking strength of 1,700 pounds per square inch." The Terre Haute Brick and Pipe Company are making brick and tile from shale that lies immediately above Coal "N." Their bank is on the N. E. N. E. Sec. 18–12–9. They make paving brick by the stiff mud process, some of which are repressed. These bricks are of excellent quality, as shown by the following tests made by Prof. M. A. Howe, for George H. Simpson, city engineer of Terre Haute, who attempted to select average (not the best) brick for the tests. The brick were supported on rounded knife edges six inches apart, and force applied through a knife edge acting midway between supports. One brick with a cross-section of 2.37x4 inches and another of 2.44x4 inches, when lying on the side, showed a cross-breaking strength of 2,630 and 2,240 pounds per square inch, respectively.

In another test, brick from the same factory had a breaking strength of 2,720, 2,780, 3,360, 1,820, 2,170, 2,310 and 3,530 pounds per square inch. A brick from the river clay, subjected to the same test, showed a cross-breaking strength of 1,440 pounds per square inch. Some common soft mud brick, from bottom-land clay in the south part of Terre Haute and burned hard, showed a cross-breaking strength of 570, 540, 890 and 920 pounds per square inch, and a compression strength of 1,410 and 2,010 pounds per square inch. A brick two thirds shale and one-third bottom-land clay showed a cross-breaking strength of 1,200 and a compression strength of 5,070 pounds per square inch. Brick made by the T. H. B. and P. Company, subjected to the absorption test, showed, after forty-eight hours in the water, .7, .7 and .22 per cent. of absorption, while the brick from the alluvial clay showed 4.34 per cent., and a Veedersburg brick 1.08 per cent. These tests show that at least some of the shales of Vigo County make good brick of the very highest quality. The shale between the limestones is of excellent quality, but it probably is not as available as the shale above. This shale extends over a considerable area, but is of no great thickness. The 12-foot outcrop on Sec. 23–12–10 is the thickest I have seen. The great shale deposit of Vigo

County is the body of shale lying over coal "N" on both sides of the river. The cliff of fine shale at Durkey's Ferry, the shale bank of the Terre Haute Brick and Pipe Company, the cliff of shale along the south branch of Honey Creek, along Stone Quarry Creek and the fine shale near Lockport all belong to the same bed. The tests made of the Terre Haute Brick and Pipe Company's brick show that this shale west of the river is of good quality. The brick from this shale are not of as dark color as those made from the shale above the limestones.

On the N. W. ¼ of Sec. 6–10–8, Pierson Township, there is a fine cliff of this shale, known as the "Paint Mine." The shale is pulverized, barreled and shipped to different parts of the country to be used as a body for paints. The company has worked under difficulties of various kinds, but no fault has ever been found with the material it sends out. The industry seems destined to grow in importance as the value of the shale comes to be appreciated. In this locality there are several ironstone bands in this shale, with many nodules of the same material. One owner of the quarry used to make hone stones from these clay ironstone layers that were of the finest quality. They were known as the "Fera hone stones." The shale from this locality makes good brick, but they are light in color. If the ironstone were crushed with the shale, the mass would doubtless make a brick of good color and great strength. There are several outcrops of this shale in Pierson, Riley and Honey Creek Townships, and some in Nevins Township. This shale is everywhere a fine aluminous shale, generally thick bedded and easy of access in scores of localities.

There is a cliff of fine shale on the S. W. ¼ Sec. 17–10–9, but I am not sure whether it is above or below coal "N." But on the north half of Sec. 13–11–9, Honey Creek Township, there is an outcrop of shale with overlying sandstone, which seems to lie above coal "N." Below it is a fine shale, which graduates upward into a fragile reddish sandstone. Specimens taken so as to represent the average of the bluff, both sand and shale, were sent to H. S. Grimes, Portsmouth, Ohio, who had them made into "Hall block" pavers. When he sent the brick to me, Mr. Grimes wrote "that there never was a better brick made." They were of a rich brown color and apparently in every way a first-class brick. They were considerably lighter than the ordinary block and somewhat larger, as they did not shrink in burning.

There are good shales at several points in Nevins Township, both above and below coal "L," but I have not been able to study them in detail.

The common mud brick used in Terre Haute are made mostly by hand from alluvial clays from the flood plains of the river. This material varies widely in composition, and never makes a really first-class brick although they may surpass many. Some portions of these alluvial deposits make excelleut dry pressed building brick, but does not make a

first-class paver, as the tests already made seem to show. Clays from which common building brick may be made abound everywhere on the uplands of the county. Some of the shale would certainly be valuable for the manufacture of at least the lower grades of pottery. A deposit of fine clay on Sec. 22–12–10 is said to be suitable for encaustic tiling and high grade pottery wares. A partial analysis of this clay by Prof. W. A. Noyes is as follows:

Silica	50.36	
Alumina	15.08	
Oxide of iron	4.45	
Loss by ignition	13.98	
		83.87
Undetermined substances		16.13
		100.00

Prof. Noyes says that the undetermined substances appear to consist largely of lime. The clay, he thinks, may be of value for earthenware and similar products.

Sandstone.—There is an abundance of sandstone in the county, but little, if any, of it is good for building purposes. In the eastern portion of Fayette Township, along the bluffs, small quantities of very good sandstone may be found, but such masses are not extensive enough to make the quarrying of it profitable. Sandstone has been quarried at two or three places along Coal Creek and on a little creek in the S. W. corner of Sec. 28–13–9, and perhaps in other places along the bluffs. It has also been quarried at different places on the east side of the river, but merely for neighborhood use.

The sandstone above coal "L" is a coarse-grained, silicious sandstone that is sometimes a very handsome stone. At Coxville, Parke County, this stone pulverizes into a very valuable glass sand. Over coal "L" at Seeleyville there is over 40 feet of this sandstone that seems to be of exceptional purity. After the coal is taken out the sandstone can be stoped down and raised to the crusher quite as cheaply as if it were in a cliff.

Limestone.—There is a double limestone above coal "N," west of the river, and a limestone over coal "M," east of the river, and one over coal "O," in Fayette Township. The limestone above coal "O" is generally so disseminated through the shale that it does not form a quarry rock. But in the top of the hill on S. W., Sec. 20, it forms a ledge of fine, compact, clayey limestone about three and one-half feet in thickness. I could form no idea of its extent. Some limestone has been quarried from the bluffs in the eastern part of Fayette, but it was simply for local use. Some has been quarried from S. W. ¼ Sec. 19–12–9, but the most extensive quarry was on N. E., Sec. 15–11–10, in the south

part of Sugar Creek Township, where rock was taken out for use in improving the river. On the east of the river considerable stone was quarried along Honey Creek near Lockport for use in improving the National Road, and occasionally for domestic purposes. I know of no limestone that has ever been burned for lime.

Iron Ores.—In the shales of the coal measures iron carbonate mixed with clay is often common. It is known as kidney iron ore or clay ironstone. This form of iron ore is abundant in the shales overlying coal "N." It occurs in nodular masses and in distinct layers or strata. When the Blast Furnace at Terre Haute was in operation hundreds of loads of this material were brought to the furnace every year. The stones were thrown out of the creek bed during the summer and hauled to the furnace during the fall and winter. While not productive of much revenue, these iron stones are worth preserving.

Other Minerals and Ores.—Governor William Henry Harrison, in a letter dated December 10, 1809, to the Secretary of War, regarding a treaty with the Kickapoo Indians, says: "I was extremely anxious that the cession should have extended to the Vermillion River. This small tract of about twenty miles square is one of the most beautiful that can be conceived, and is, moreover, believed to contain a very rich copper mine. The Indians were so extremely jealous of any search being made for this mine that the traders were always cautioned not to approach the hills that are supposed to contain this mine. I know there are individuals who have turned their attention toward this mine, and will probably prevail upon the Indians to show them the mine." He then urges that the Government take immediate steps to secure this tract of land. The tract mentioned included a portion of Vigo County west of the river.

This old tradition is still alive, and has grown somewhat. The mine now contains silver, as well as copper, and is talked of in secret and with bated breath, as if there was still danger attending upon the approach toward those hills. The copper consisted of specimens of native copper, brought by the glacier, of which many have been found in Vigo, Vermillion and Parke Counties. I have one weighing $19\frac{3}{4}$ pounds, found in Parke County, that has on it well defined glacial striæ. The silver is the whitest kind of iron pyrites, so common in the shales of the coal measures. No copper, silver, nor gold has ever been found in paying quantities in connection with coal formations, and we can not hope to find them in Vigo County.

Mineral Oil.—Oil seems to be abundant in the deep strata of Vigo County and, when found, is a source of considerable revenue. It seems probable that at no distant day a more extensive field may be opened, and the production of oil become one of the important industries of Vigo County.

Natural Gas.—The flow of natural gas was so strong from some of the artesian wells that many have thought that we are in the gas belt, but as yet it has not been found in paying quantities.

Sulphur Water.—The sulphur water, so abundant from the artesian wells, is a valuable medicinal agent. It is especially useful in rheumatic complaints, and many other ailments are benefited by the use of this water for bathing or drinking.

ARCHÆOLOGY.

The relics and remains of ancient pre-historic peoples are found in many parts of the earth. The river and its larger tributaries abounding with food fishes and mussels, the forests and prairies crowded with game birds and animals that were valuable for their flesh, skins or fur, and the rich, easily tilled soil of the readily accessible second bottoms made Vigo County and vicinity a favorite dwelling place for primitive man. When the French traders penetrated these regions they found Indian villages on the Terre Haute Terrace, and evidences that they had been occupied for uncounted centuries.

As the region was more carefully explored, the remains of an ancient, and apparently a different people, were found—a people whose historic records are limited to fragments of bones, bits of charcoal, broken pottery-ware and masses of kitchen refuse—to implements of bone, flint and stone, to desecrated shrines and violated tombs.

These people are known as the "Mound Builders," because of the great number of earth mounds which they built and used for various purposes. The most numerous are the burial mounds, and these are generally the smallest in size. In addition to the burial mounds there were temple or sacrificial mounds, and lookout or signal mounds. The burial mounds are usually artificial and so are the sacrificial mounds, but the signal mounds are often partly natural.

There are in Vigo County, perhaps, 300 mounds. In Otter Creek Township there is a group of mounds on the edge of the terrace in the S. W. $\frac{1}{4}$ of Sec. 14-13-9. The largest one of this group is about 10 feet high, 50 feet in diameter at the base, and about 20 feet in diameter on the summit. On this mound several oak trees were growing. A large one that had been cut down showed 203 rings of annual growth. The terrace at this place rises about 50 feet above the flood-plain, and at present is about one mile from the river. There are a few small mounds on the west bluff of Otter Creek in the N. E. $\frac{1}{4}$ Sec. 27 nearly 50 feet above the creek. There are a few mounds on the prairie near Fort Harrison, in the S. W. $\frac{1}{4}$ Sec. 3 and S. E. $\frac{1}{4}$ Sec. 4 of Harrison Township. There are mounds in the S. E., S. E. Sec. 32-12-9, on the N. E., S. E. and S. W. quarters Sec. 5-11-9, on S. fraction Sec. 6, and N. W. $\frac{1}{4}$ Sec. 7-

11–9, these forming a group of more than 100 mounds, extending for two miles along the edge of the terrace which rises from 30 to 40 feet above the flood-plain. The mounds of this group vary greatly in size, from 30 feet in diameter and an elevation of six feet, down to five feet in diameter and one foot in elevation. Many of this group have been obliterated by cultivation. There are a few mounds about nine miles south of this group on the N. E. ¼ Sec. 9, Tp. 10 N. R. 10 W., on ground that just rises above high water. Another group of interesting mounds is situated in the valley of Prairie Creek on the N. W. ¼, N. W. ¼ Sec. 28, and the S. ½ Sec. 21, and on the S. E. ¼, S. E. ¼ Sec. 20, Tp. 10 N., R. 10. W. Some of these are just above high water, while others are on the hillside at least 40 feet above the floods. In the S. E. corner of Sec. 29, Prairie Creek Township, there is a hill or mound about fifty feet high which seems to have been a point of the bluff that was topped out by the mound-builder and used as a signal mound. The summit has been used as a burial place, but probably by tribes of a later date than those who used the mound for signal purposes.

In Sullivan County, south of this mound, there are several large mounds, rising to an elevation of about 75 feet above the flood plain, and from 25 to 30 feet above the terrace. About one-half mile back from the edge of the terrace, on the N. E. ¼ Sec. 8 9-10, there is one that has an elevation of about 40 feet, a length from east to west of about 400 feet, and from north to south of about 300 feet. It is, perhaps, the largest and most symmetrical mound in the State. These large mounds were, perhaps, burial mounds, but they have never been explored. Two on the edge of the terrace, on Secs. 6 and 7, might have been signal mounds. But why so near each other? Why little mounds for 20 miles through Vigo County, and then a few large mounds without little ones? On the top of the one on Sec. 6 there is a secondary mound in which was a stone grave containing several skeletons. These may have been the remains of later tribes.

On the west side of the river there are mounds on Sec. 34–15–9, six miles north of the county line, and some on Brouilett's Creek, in some of which were stone graves. But the only ones in Vigo County are a small group on the second bottoms near Macksville. Just south of Darwin, across from the big mounds of Sullivan County, there is a large group of rather small but symmetrical mounds. Bones from these mounds are badly decayed. It is seldom that a bone is found in a good state of preservation, while bones from the stone graves at Merom, in Sullivan County, are often well preserved.

If these 300 mounds represent all the burials, then the Mound Builders made but a short stay in this vicinity and occupied but a small portion of its area. If they represent the burials of the priest and ruling families only, still their stay must have been comparatively brief. Bones

of men, women and children have been found in these mounds, indicating that they were family burial places. If these mounds do not represent all the burials, how were the remains of other families disposed of? Possibly they were buried, but the evidence of this is not very clear.

The large group along the terrace in Secs. 32, 5, 6 and 7, mainly in Honey Creek Township, are nearer the river than any of the others, and this location may possibly indicate that the river flowed along the terrace when the mounds were built, as it does now, and that they were built at a comparatively recent date. The location of some of the mounds along Prairie Creek, and of the mounds below Darwin, seem to point toward the same conclusion.

On the N. E. ¼, N. E. ¼ Sec. 29–10–10, there are the remains of an ancient pottery. The fragments of pottery scattered through the soil, over a considerable area, indicate that it was quite an extensive affair.

Many of the smaller mounds have been opened, that is a hole has been dug in the center of the summit. Very frequently portions of skeletons have been found, but none in a good state of preservation. One skull, taken from a mound on Sec. 21–10–10, had the marks of an idiot's skull, so that unfortunates or imbeciles are not the exclusive product of civilization. Besides the bones of the Mound Builder and the mounds that were built over them, some evidences of his skill, industry, habits, enterprise, etc., have been found. Among them are stone axes, stone celts or hatchets, flint implements, as arrow points, spear heads and rimmers, ornaments of copper, mica, galena, hematite, of shells and bones, pipes of stone and slate, and catlinite, a discoidal stone of symmetrical form, made from a quartzite pebble, etc. These implements and ornaments indicate considerable skill and intelligence, industry and energy, and that the makers were possessed of no mean artistic ability. The copper, galena, mica, slate and hematite indicate extensive commercial relations. The pipes tell the story of raising tobacco, of crude agriculture and dreamy contemplation.

The remains of the Mound Builder found in Vigo County perhaps add nothing to our knowledge of these ancient people, but they confirm in many respects the conclusions arrived at from the study of relics found in other localities. Who were the Mound Builders? Where did they come from, and what became of them? It does not seem possible for us to find out the history of these people. The following seems a probable account of them. These people came from the western plains into the forests and prairies of the Ohio Valley. They had made considerable advance in culture, lived in communities under settled forms of government and religion. Agriculture and commerce were important industries. The custom of building mounds was unique; it seems to have been developed in the Ohio Valley, and never was practiced to any extent elsewhere. The rich soils of the river valleys yielded an abundant

return for their labor, but the rank growth of native vegetation made agriculture a more arduous industry than in the drier regions of their ancestral home. With crude and inefficient tools, and without domestic animals, it was difficult to defend the growing crops from the vigorous natural vegetation. There was an abundance of game and fish, wild fruits, berries and edible roots growing everywhere. Surrounded by such a wealth of natural products, more and more of the people became fishermen and hunters. Agriculture was neglected, the towns were deserted, forms of culture were dropped, till finally they sank to the level of surrounding tribes, and, broken up by cruel, savage warfare, were gradually destroyed or absorbed by neighboring people. Primitive man has seldom practiced agriculture successfully in a forest region. Whatever may be their history, we must ever feel a lively sympathy for this people, who, outstripping their contemporaries, came very near making a permanent advancement; then, overcome by their environment, gradually dropped out of the race and sank into oblivion.

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